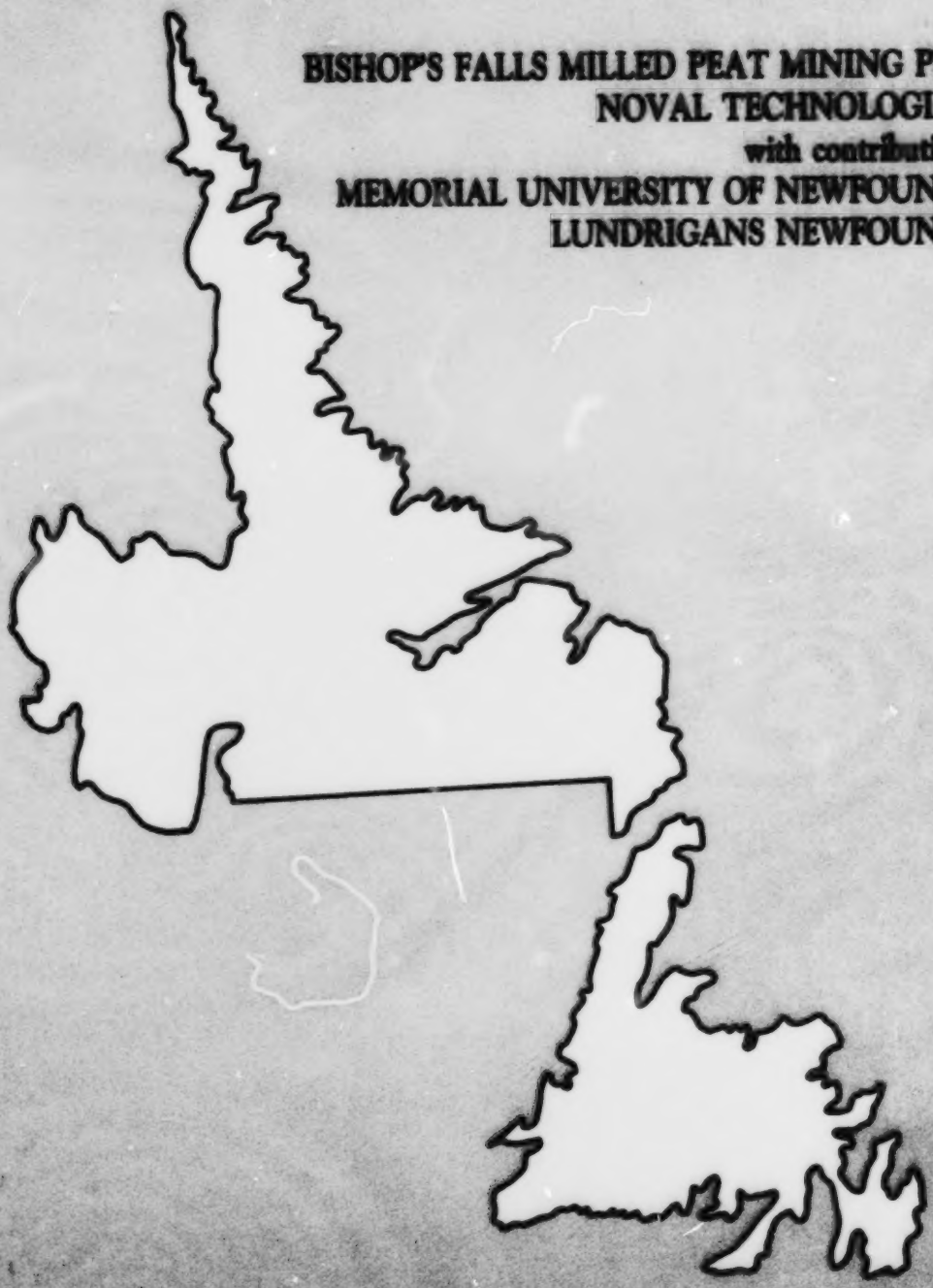
CANADA / NEWFOUNDLAND

CONSERVATION AND RENEWABLE ENERGY DEMONSTRATION AGREEMENT

# BISHOP'S FALLS MILLED PEAT MINING PROJECT

NOVAL TECHNOLOGIES LTD.
with contributions from
MEMORIAL UNIVERSITY OF NEWFOUNDLAND
LUNDRIGANS NEWFOUNDLAND



CR 85-70

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# BISHOP'S FALLS MILLED PEAT MINING PROJECT

Prepared for:

Energy Branch
Department of Mines and Energy
Government of Newfoundland and Labrador
P. O. Box 4750
St. John's, Newfoundland
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St. John's, Nfld.

With Contributions from:

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# CANADA/NEWFOUNDLAND CONSERVATION AND RENEWABLE ENERGY DEMONSTRATION PROGRAM

Because of the sharp increases in the cost of oil, natural gas and electricity within the past 15 years, the search is on for economical sources of energy. Affordable energy, now and in the future, concerns everyone.

In June 1979, to help meet this demand for conservation and alternative sources of energy, the Government of Canada and the Government of Newfoundland and Labrador signed the Conservation and Renewable Energy Demonstration Agreement (CREDA).

The objectives of this $11,250,000 cost-shared program (Federal 80%, Provincial 20%) included the following:

- to develop and demonstrate promising new technologies which use renewable energy resources;
- to develop and demonstrate new and efficient technologies which conserve energy;
- to create employment in new and existing energy related industries;
- to inform the public of the economical use of new technologies as they apply to the energy resources of Newfoundland and Labrador.

The CREDA program ended March 31, 1985. For more information on this and other energy projects funded under the Canada/Newfoundland CREDA program contact:

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# PROGRAMME CANADA/TERRE-NEUVE DE DÉMONSTRATION DES ÉCONOMIES D'ÉNERGIE ET DES ÉNERGIES RENOUVELABLES

La montée en flèche du coût du pétrole au cours des 15 dernières années, du gaz naturel et de l'électricité a rendu nécessaire la recherche de sources d'énergie à bon prix. La question de l'énergie à coût abordable, pour aujourd'hui et les années à venir, touche tous les Canadiens.

Pour aider à répondre aux besoins en matière d'économies d'énergie et d'énergies renouvelables, le gouvernement du Canada et le gouvernement de Terre-Neuve et du Labrador ont ratifié en 1979 au Accord de démonstration des économies d'énergie et des énergies renouvelables (ADEEER).

Ce programme a été doté d'un budget de 11,25 millions de dollars, et le gouvernement du Canada et celui de la province s'en partageant les coûts dans une proportion de 80% et 20% respectivement. Quelques-uns de ses objectifs étaient:

—La mise au point et la démonstration de nouvelles techniques prometteuses faisant appel aux énergies renouvelables;

—La mise au point et la démonstration de nouvelles techniques efficaces d'économie d'énergie;

—La création d'emplois dans des entreprises nouvelles ou existantes oeuvrant dans le domaine de l'énergie;

—Faire connaître au public les avantages économiques de ces nouvelles techniques telles qu'applicables aux ressources énergétiques de Terre-Neuve et du Labrador.

Le programme ADEEER prendra fin le 31 mars 1985. On peut obtenir plus de renseignements sur le programme ou sur les sujets qui ont fait l'objet d'une aide financière en vertu de l'Accord Canada — Terre-Neuve sur les économies d'énergie et les énergies renouvelables en communiquant avec:

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# Disclaimer

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Mines & Energy Newfoundland

# Fuel Peat Harvesting
## Noval Technologies Limited

CREDA Project

**Canada/Newfoundland Conservation and Renewable Energy Demonstration Agreement**

**Project Location:**
High Point Bog, Bishop's Falls
Abitibi-Price Inc., Grand Falls

**Project Manager:**
D. G. Rees
Noval Technologies Ltd.
Suite 710, Atlantic Place
St. John's, Nfld. A1C 6C9

**Date:**
October, 1982

**Project Number:**
03:04:03

**Status:**
Field activity completed

**Technology:**
Biomass - peat

**Sector:**
Industrial

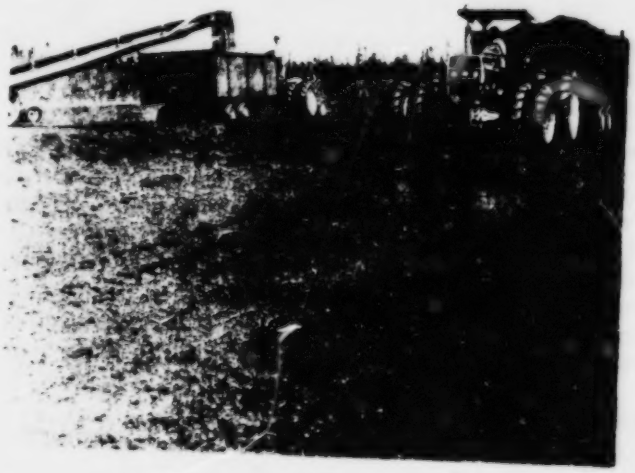
**Province:**
Newfoundland

**Purpose:**

To demonstrate the feasibility of 1) mining fuel peat using the Haku and Vacuum methods and 2) burning fuel peat in an industrial setting.

**Description:**

A 20 hectare area of peat bog in varying stages of decomposition was harvested during the summer of 1981 and 1982, and in the fall fuel peat was transported for burning in an existing hog fuel boiler at Abitibi-Price Pulp and Paper Mill.



**Contributors:**

| | | |
|---|---|---|
| Canada | (CREDA) | $ 653,280 |
| Newfoundland | (CREDA) | 163,320 |
| Memorial University of Nfld., Lundrigans Newfoundland Limited and Noval Technologies Ltd. of Alberta | | 552,000 |
| | Total | $1,368,600 |

**Expected Benefits/Savings:**

Fuel peat harvested at the High Point Bog is expected to replace almost 3,000 barrels of oil at the Abitibi-Price mill. The long-range potential impact is substantial since the methods developed for harvesting and burning fuel peat in Newfoundland could be used by other provinces with unexploited peat resources.

**Further Information:**

The information transfer component will include: - sign - brochure/poster - seminar - film - slide show - display - on-site tours - final report.

**Information Contact:**

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Noval Technologies Ltd.
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215 Water Street
St. John's, Newfoundland
Phone: (709) 722-2815

or Clarissa Dicks, Information Coordinator
Department of Mines and Energy
P. O. Box 4750
St. John's, Newfoundland
A1C 5T7
Phone: (709) 737-2411

**Project Name:**

Fuel Peat Harvesting

**Economic Analysis:**

**Project Costs:**

| | |
|---|---|
| Capital | $ 596,529 |
| Installation | 572,133 |
| Management | 190,438 |
| Total installed cost | $1,359,100 |
| Information Transfer | 9,500 |
| Total demonstration cost | $1,368,600 |

**Energy Impact**

In general, one ton of fuel peat at 50% m.c. is approximately equivalent in energy content to one barrel of Bunker C. Assuming a fuel peat yield of 140 ton/ha per season, an area of approximately 1000 ha would be required to satisfy the annual fuel requirements of one of the boilers at the Abitibi-Price mill in Grand Falls.

**Monitoring/Evaluation:**

Data is being collected on:

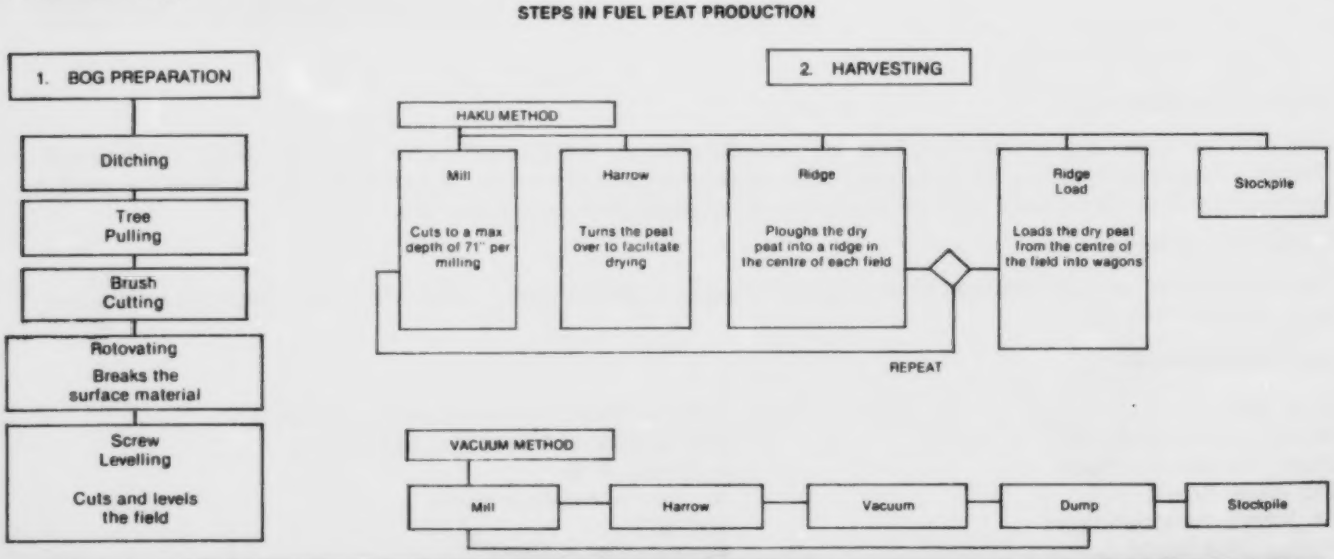
1. Production rates for each project activity (project employees).
2. Environmental impacts of peat harvesting on water, air, vegetation and wildlife conditions on the bog (by a coordinated environmental monitoring program involving various provincial and federal departments).
3. Peat burning (by Abitibi-Price).

The joint venture partners have developed a computer model which can simulate a fuel peat production system based upon the weather, manpower and equipment. This model can be used to simulate harvesting at any site where adequate statistics are available.

**Technical Details/Specifications:**

The bog preparation and maintenance required a modified MF275, a screw leveller and a Dondi ditcher. The harvesting equipment is handled by tractors. An MF285 (4x4), an MF255 (4x4), an MF255 and an MF275 were purchased for the project. The Haku method required a miller (cuts loose a thin layer of peat from the drained bog surface); a harrow (equipped with hockey-stick-shaped spoons designed to flip the milled peat over); a ridger (ploughs the dried fuel peat into a ridge in the center of each field); and a ridge loader (raises the ridge of dried peat off the bog into a wagon). The Vacuum method required a miller, a harrow and a vacuum harvester (collects the dried peat off the bog and transports it to the storage area).

**Schematic Diagram:**



## ABSTRACT

### Bishop's Falls Milled Fuel Peat Mining Project

Between 1979 and 1982, the feasibility and viability of milled fuel peat mining was investigated. Both the Haku and vacuum harvesting systems were used. The mining operation and burning were successful, and production cost figures were developed.

Peat cost $6 to $7 per tonne at the stockpile, excluding overheads and development costs. One tonne replaced 162 L (1.02 barrels) of Bunker "C" at $30/bbl, or better than 1.4 bbl if the moisture content were kept low. A cash flow model revealed that even so, the return on investment was too low to make a commercial operation viable.



## RÉSUMÉ

### Projet d'Extraction de Tourbe Moulu pour Fins Energetiques à Bishop's Falls.

Entre 1979 et 1982, on a étudié la faisibilité et la viabilité de projets d'extraction de tourbe moulue pour fins energetiques en essayant deux modes d'extraction soit le système Haku et le système à aspiration. On a obtenu de bons résultats d'exploitation et de combustion, et réussi à déterminer les coûts de production.

La tourbe coûte de 6 a 7 $ la tonne, aux stocks de réserve, exclusion faite des frais généraux et des coûts de mise en valeur. Une tonne pourrait remplacer 162 L (1,02 baril) de mazout de soute "C" a 30 $ le baril, ou plus de 1,4 baril si l'on contrôle la teneur en humidité de la tourbe. Pourtant, un modèle de simulation de la marge brute d'autofinancement révèle que le rendement de l'investissement est trop faible pour en faire une exploitation commerciale viable.

## ACKNOWLEDGEMENTS

Noval Technologies Limited would like to thank the Provincial and Federal governments for their support of this project. As well, the input from others such as Memorial University of Newfoundland, ShawMont Newfoundland Limited, Montreal Engineering Company Limited, and the many firms which assisted in this project was greatly appreciated.

Noval would also like to thank Mr. David G. Rees for managing the project and preparing this report, and the management and staff of Abitibi-Price Limited, for their irreplaceable help in the acquisition of data (and experience) on the burning of Newfoundland fuel peat.

A special word of thanks is due to Dr. Dale Hull and Ms. M. Blackmore for the economic and socio-economic analyses.

This report was edited for CREDA by David Bazeley.

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## EXECUTIVE SUMMARY

A project to investigate the mining of fuel peat in Newfoundland was carried out on High Point bog near Bishop's Falls from 1979 to 1982. The project was a joint venture of Noval Technologies, Memorial University of Newfoundland, and The Lundrigan Group. Major financial support came from the Canada/Newfoundland Conservation and Renewable Energy Demonstration Agreement.

The objectives of the project were to assess: the feasibility of mining fuel peat for the commercial and utility sectors as a replacement for oil; the capabilities of existing equipment to work on Newfoundland bogs; and the suitability of storage and handling facilities at the burning plant, and to develop cost data for all relevant activities.

Standard methods of bog drainage and field preparation were used. Two operationally proven harvesting methods were employed, the Haku ridge loading system and the vacuum harvesting system. The peat was sold to Abitibi-Price for burning at their paper mill in Grand Falls, at $25/tonne.

The project objectives were achieved. It was feasible to mine fuel peat in commercial quantities in Newfoundland, and existing equipment was capable of working successfully. The storage system was not totally suitable, since heavy rain in the Fall resulted in excess reabsorbtion of moisture in peat stockpiles, especially from the paved storage area at the mill. The furnace facilities were capable of burning the peat, though not ideal.

Cost data were developed for all production activities. Peat was produced for a direct cost of between $6.08 and $7.27 per tonne, depending on the system used. Development costs were estimated as $3000 per hectare, and initial capital investment required as $490,000 for a 5-tractor, 100 ha operation. Loading and transportation averaged $7.75 per tonne. The peat was found to be equivalent to 162 L (1.02 bbl) of Bunker C per tonne of peat at 63% moisture content. With oil at $29.60 per barrel, the potential for significant savings was demonstrated. However, a cash flow model of a commercial scale operation showed an overall return on investment of only 0.23%. The most significant factors in this were transportation cost and selling price.

# INTRODUCTION

## PROJECT BACKGROUND

**Initiation**

In the mid 1970's dramatic increases in the price of oil on the world market resulted in a search for alternate sources of energy. Accordingly, the use of peat as a fuel gained increasing support. In 1979, the Newfoundland Fuel Peat Demonstration Project was initiated in Bishop's Falls, Newfoundland. The project was seen as a practical step towards reducing the Province's dependency on foreign oil, and as a move to encourage a potentially important regional industry. The project was the result of more than two years of preparation by Memorial University of Newfoundland (MUN) and the Provincial Department of Mines and Energy.

In mid 1978, Noval Technologies Ltd. (a wholly-owned subsidiary of Nova, an Alberta Corporaation of Calgary, Alberta) expressed an interest in participating financially in the University's program. This offer enabled the program to move from the conceptual stage to the demonstration level.

**Participants**

The project was operated through an agreement between MUN, Noval Technologies, and The Lundrigan Group, a major general contractor in the Province. The University was assigned the responsibility of project management and administration in association with the regulatory agencies of the Provincial Government.

Various consultants were contracted to provide engineering support, reporting through MUN to the project sponsors. A three-stage study was carried out to evaluate peat resources in the Province and identify potential customers, evaluate the technical and economic aspects of the selected development program, and to outline the operating methods and costs of such a program.

The extent to which peat deposits were close to potential users was assessed. Although a number of suitable deposits were identified, the Grand Falls area was preferred because it had sufficient deposits close to a major potential user, and the climate there was better suited for obtaining peat at acceptable moisture content than in most other areas.

Abitibi-Price (Newfoundland) Limited agreed to purchase 10,000 tonnes of fuel grade peat from the project for the burn test trials. In theory, the peat would replace up to 500,000 of the 12,000,000 gallons of oil used annually by their paper mill at Grand Falls.

**Environmental Monitoring**

All necessary permits were obtained from government departments and the Town of Bishop's Falls before operations began. The Provincial and Federal environmental protection agencies gave full support to the project, with the requirement that they be allowed access to carry out a comprehensive monitoring program of the environmental conditions over the life of the project.

## PROJECT OBJECTIVES

The objectives of the project were:

(1) to assess the feasibility of mining fuel peat as a replacement for imported fuel oil in the industrial and utility sectors of the Newfoundland economy;

(2) to assess the capabilities of existing peat mining and transportation equipment on Newfoundland bogs;

(3) to assess the peat storage and handling facilities at the burning plant; and

(4) to develop cost data for mining, transportation and burning of peat.

## PROJECT FINANCING

**Initial Agreement**

The initial agreement between MUN, Noval, and Lundrigan's commenced on June 1, 1979. It was to last for 43 months, unless agreement for extension was reached prior to the expiration date. Funding was solicited from government under the Canada/Newfoundland Conservation and Renewable Energy Agreement (CREDA). The proposed funding was as follows:

| | |
|---|---|
| CREDA - Canada | $480,000 |
| - Nfld | 120,000 |
| Noval | 250,000 |
| Lundrigan's | 50,000 |
| MUN | 174,000 |
| Total | $1,074,000 |

MUN's contribution was to be given in the form of management services and expertise; Lundrigan's in the form of goods, services, equipment and labour; and Noval's in money or in the form of expertise or goods.

On March 20, 1981 the final project agreement with the Provincial Government (on behalf of Newfoundland and Canada) was signed. This agreement explained in detail the terms of the draft agreement dated June 1, 1979. The agreement provided a financial framework so that Newfoundland and Labrador and its contractors could implement the project.

**Extension**

On September 13, 1982, an amendment was made to the 1981 agreement. The purpose was to grant a one year extension and to provide for additional project expenditures. Additional funding agreed was:

| | |
|---|---|
| CREDA..... | $207,000 |
| Noval..... | 68,000 |
| Lundrigan's..... | 10,000 |
| Revised Total... | $1,359,000 |

The new termination date was set for March 31, 1983.

## PEAT TYPES

**Definition**

Peat can be described as partially decomposed plant matter which occurs in water-saturated enviromnments where there is a lack of oxygen. In this type of environment the accumulation of plant matter is more rapid than its decomposition.

**Classification**

Peat is classified using the Von Post scale, which uses the recognizable features of the original plant constituents which formed the peat. Peat is classified according to its degree of humification. The scale is given in Appendix A.

Organic soils can be divided into four main groups: folisol, fibrisol, mesisol, and humisol. The first is saturated forest litter. The other three are saturated organic matter at various levels of decomposition.

Soils of the folisol group consist typically of thick layers of leaf litter, twigs, branches and mosses overlying rock or fragmented material. Unlike other organic soils, they are not composed dominantly of mosses, sedges and other aquatic plants. This type of material cannot be classified as peat.

Soils of the fibrisol group are composed of relatively undecomposed fibric organic material. Fibric material is usually classified on the Von Post scale as 1 to 4, and is the least decomposed type of peat. It is usually used for horticulture.

Soils of the mesisol group are at a stage of decomposition between fibrisols and humisols. It is usually classified as 5 to 6 on the Von Post scale, and can be used as fuel peat.

The humisol group soils are the most decomposed. Most of the material is humified, and there are few recognizable fibres. The classification is 7 or higher, and they are used mainly as fuel peat.

## PROJECT TIMETABLE

**Development** Planning, site selection, and investigation were all completed within the first year. The development of High Point bog began during early 1980, and was basically complete by the spring of 1981.

**Production** The first peat was harvested in the summer of 1981, when about 400 tonnes was produced and shipped to Grand Falls. The following year saw full production on the seven best fields. From these over 1150 tonnes were harvested and shipped. A scedule of project activities is presented in Appendix B.

## PROJECT ACTIVTIES AND OBSERVATIONS

### BOG EVALUATION AND SELECTION

**Regional Selection**

In 1979, consultants were retained to select a suitable fuel peat bog and to assess the markets for fuel peat in Newfoundland. Four potential large-scale users were identified: ERCO Industries Limited, Price (Newfoundland) Pulp and Paper Limited, Bowater Newfoundland Limited and Abitibi Paper Company Limited. Price (later to become Abitibi-Price) agreed to purchase peat from the project for burn test trials. Therefore it was essential to chose a site within a reasonable distance of Grand Falls where the peat would be burned.

**Preliminary Survey**

Aerial photography revealed twenty-two bogs of appropriate size having some form of access, and lying within 25 km of Grand Falls, a distance felt to be about the maximum desireable for transportation. These bogs are shown in Figure 1. To provide a rational method for screening the bogs, about which little first-hand information was available, a ranking system was devised. Eight principal factors were considered: ownership, surface area, accessibility, surface water coverage, proximity to the plant, environmental considerations, resource quantities, and the ratio of each peat type present.

The possible range for each factor was divided arbitrarily into three or four categories, with weighting values applied to each category. The score for each bog was then assessed, and five bogs selected as prime candidates. High Point bog was recommended for the project site. Details of the ranking and evaluation system employed are given in Appendix C.

**Site Location**

High Point bog is located on the Exploits River eight kilometres northeast of Bishop's Falls, in Central

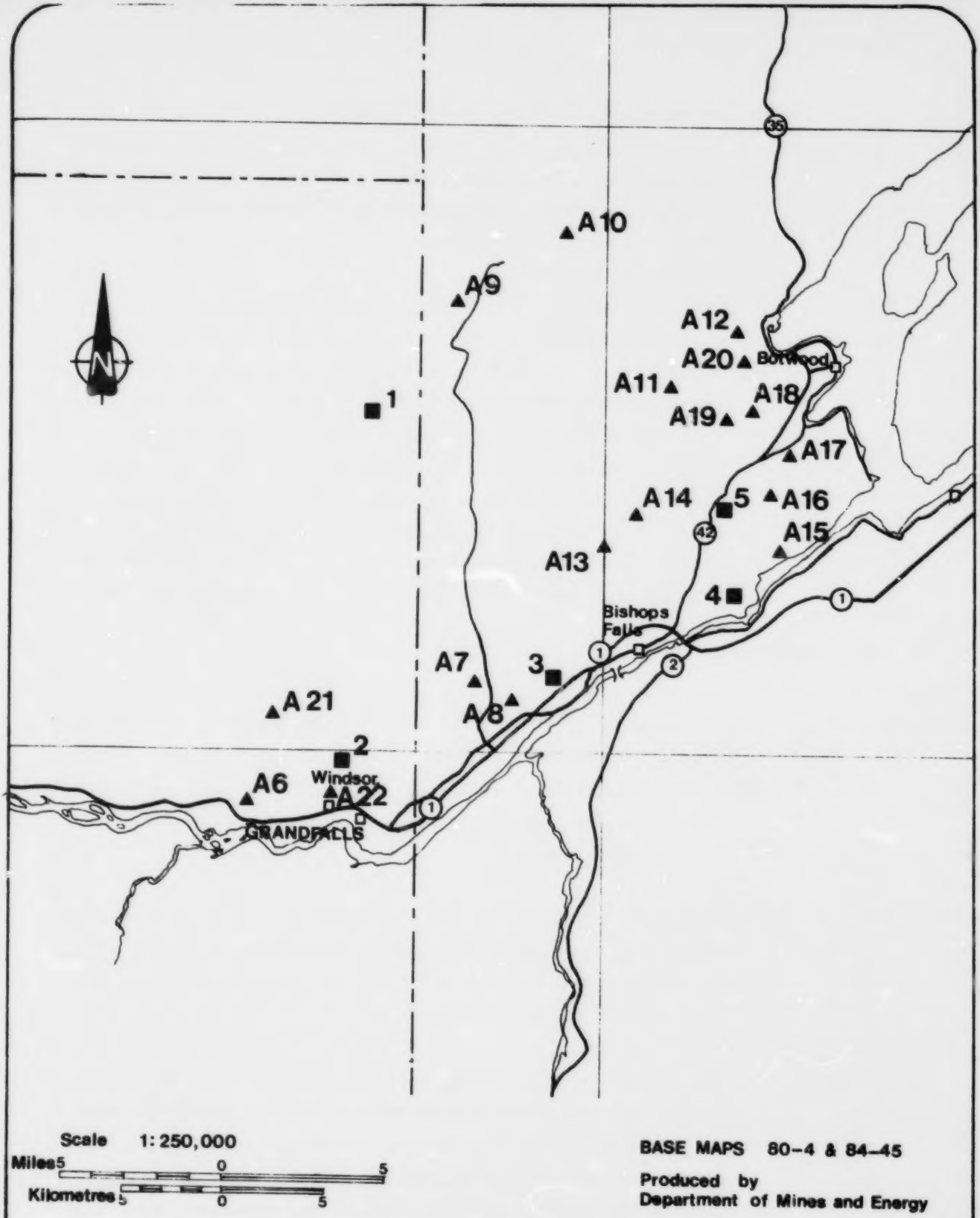


Figure 1. Location of Potential Sites

Newfoundland, and about twenty kilometres northeast of Grand Falls (Figure 2). It is situated on a glacio-fluvial terrace, approximately 10 m above the river, into which it drains through two brooks. The entire area is Crown Land, and no land use conflicts were apparent.

**Site Description**

The total area of High Point bog is 267 ha. Both fuel and moss peat are present, with an area of approximately 60 ha in the northern section being capable of supporting almost immediate fuel peat production (Figure 3). This area was surveyed in detail and samples taken on a 100 m grid. The results are shown in Figure 4 and Table 1. "Mining Section" refers to the area where the fuel peat was more than 1 m thick. "Prime Mining Section" refers to the area within the mining section where the overlying moss peat was 1 m or less in thickness. Survey maps of the bog are presented in Appendix D.

The total amount of fuel peat in the mining section was estimated to be 295,000 tonnes at 50% moisture content, in an area of 59 ha. At the expected annual production rate of 250 t/ha, this would be sufficient for about 20 years at 15,000 tonnes per year, allowing for a declining surface area over the life of the mine.

Laboratory tests of the samples gave the <u>in situ</u> moisture content as 90 to 95%, with an average heat value of 4615 cal/g on a dry weight basis. These laboratory tests are documented fully in Appendix E.

**Mining Methods**

Two methods of peat mining were selected for use, the Vacuum method and the Haku Ridge-loading method. Both had been successfully employed in Europe, particularly in Finland. The primary difference in the methods was the equipment used to pick up the peat; otherwise much of the necessary work was the same (see Appendix K for Photographs).

Figure 2. Location of High Point Bog.

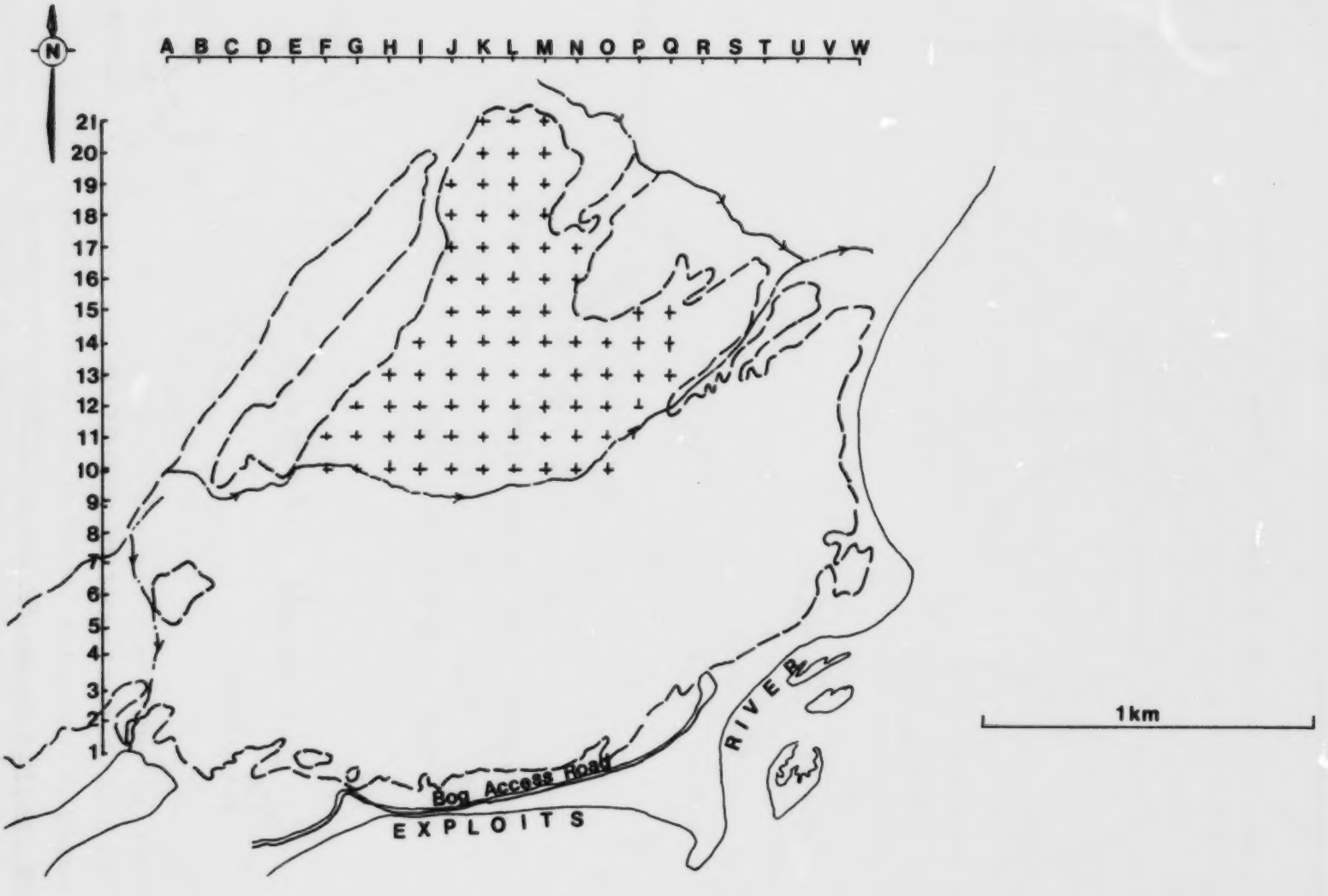


Figure 3. High Point Bog Showing Borehole Locations.

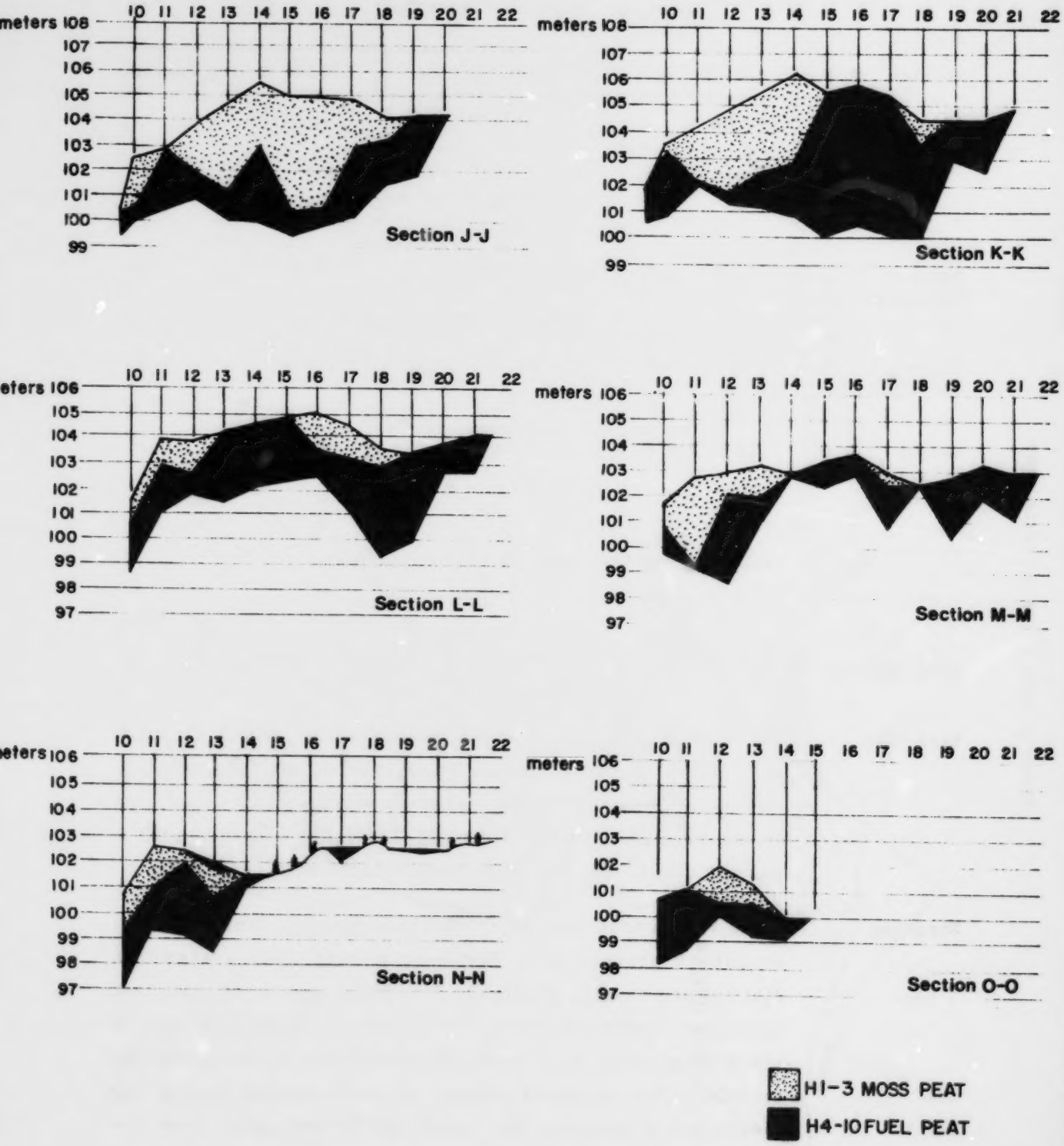


Figure 4. Depth of Peat Resources in High Point Bog

| Location (refer to Figure 5.) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Section | North End of Bog | | | Mining Section | | | Prime Mining Section | | |
| Area | 93 ha | | | 59 ha | | | 40 ha | | |
| | Moss Peat | Fuel Peat | Total | Moss Peat | Fuel Peat | Total | Moss Peat | Fuel Peat | Total |
| Average Thickness (m) | 1.3 | 2.0 | 3.3 | 1.1 | 2.0 | 3.1 | 0.3 | 2.2 | 2.5 |
| Volume ($m^3 x 10^6$) | 1.2 | 1.8 | 3.0 | 0.6 | 1.2 | 1.8 | 0.1 | 0.9 | 1.0 |
| Weight ($t \times 10^6$) 50% MC | 0.1 | 0.5 | 0.6 | 0.1 | 0.3 | 0.4 | 0.01 | 0.2 | 0.2 |

**Table 1. Peat Resources in High Point Bog**

## SITE PREPARATION

**Mine Plan**

The mine plan adopted for the demonstration project is shown in Figure 5. The 20 m spacing of the fields was determined by the characteristics of the equipment which would be used, and by the requirements for drainage. The field length of 400 m was not ideal, but was considered satisfactory.

**Ditching**

Since virgin bogs are about 93% water in situ, draining is an essential prerequisite for peat mining. Two systems of ditches are usually employed. A primary system of main and perimeter ditches prevents the inflow of water from outside the working area, and lowers the water table in the immediate vicinity. The secondary system of field ditches drains the fields and accelerates the runoff of surface water from the fields.

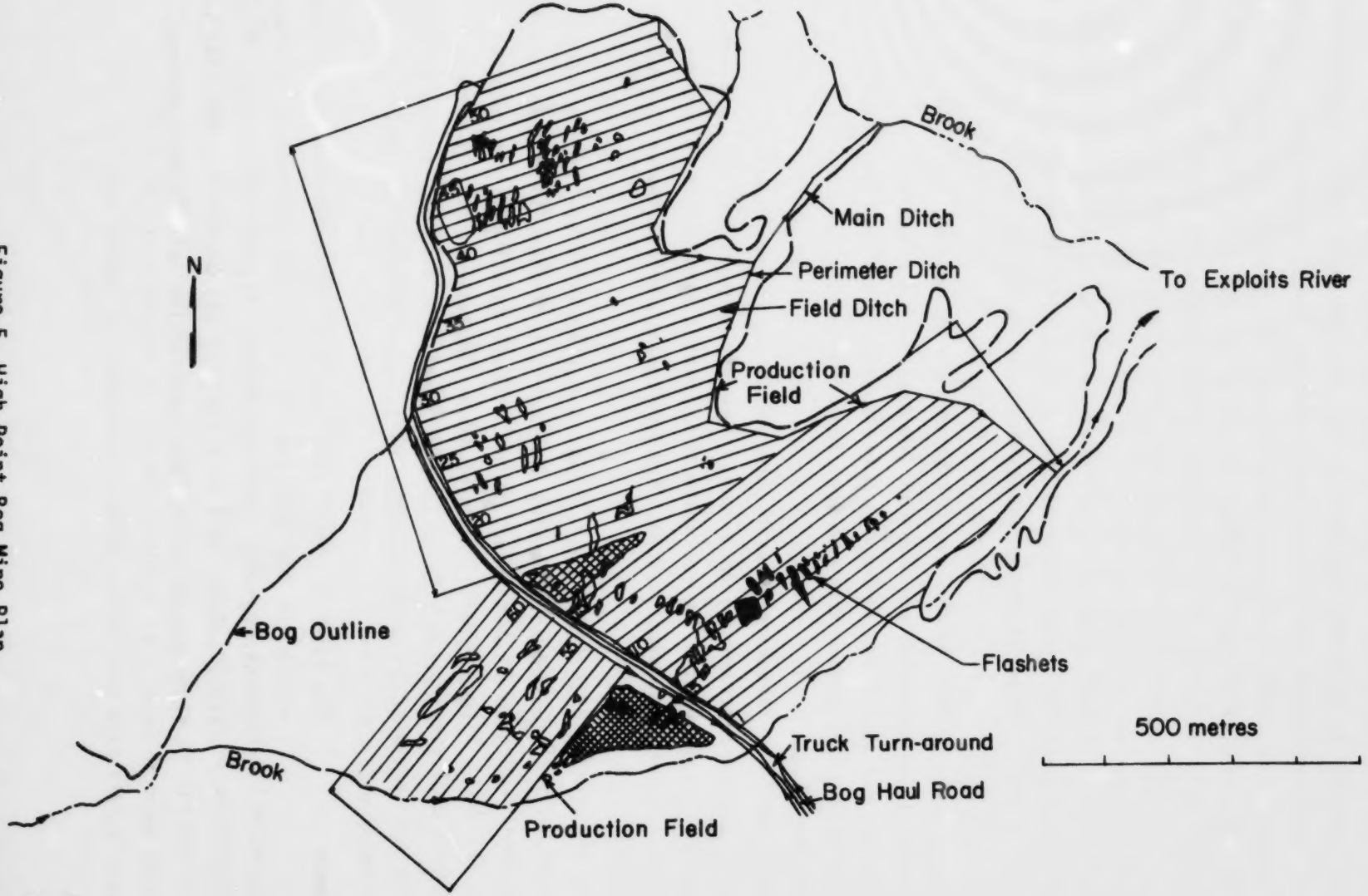


Figure 5. High Point Bog Mine Plan

Figure 5. High Point Bog Mine Plan

Good ditching is the key to good drainage and success in peat mining. At High Point, the main ditches, which fed into a catchment basin and thence into the natural drainage network, were cut first. Next, the perimeter ditches were cut to protect the mine area from inflowing water and begin the bog drainage. The field ditches were cut last. The ditch layout is also shown in Figure 5. The main and perimeter ditches were cut with a backhoe, since they required flexible sizing.

Each field ditch started at a perimeter ditch, and controlled the water table within the fields. A disc ditcher was used, mounted on a Massey-Ferguson tractor. The tractor was modified to widen the track in order to straddle the ditch. Each ditch required three cuts to produce the final cross-section of .160 m at the top, .030 m at the bottom and 1.000 m deep. Every tenth field was cut as deep as possible, to enhance drainage even further.

Best results were obtained during the early winter, when the frozen surface supported the weight of the equipment. However, on occasion the ice on a flashet gave way under the tractor. Flagging of major flashets before freeze-up would be a good idea.

Some field ditches were experimentally cut with a backhoe, consequently having vertical sides. These were less durable than the tapered ditches, though maintenance was required on that type also. Maintenance was both manual, to remove the occasional large lump of peat which fell in, and mechanical when the ditch needed to be recut with the ditcher.

**Roads**

Two types of roads were required: an access road, and roads within the bog area for the production activities. A track already existed from the Botwood Highway (Route 350). This track was upgraded to a standard all-weather unpaved road in 1979. Regular woods road construction methods were employed.

A special road was required within the boundary of the bog. This road had to accomodate not only large trucks for transporting the peat, but the special equipment used for harvesting. Some of this equipment had metal drum "wheels" which could not travel on mineral soil, and so a second road had to be constructed using peat.

The road was routed on the highest point of the bog so that drainage would be away from the road. Ditches were cut alongside the road to facilitate the drainage. Spoil from the fields was used to build up the roadbed.

On some parts of the road, the surface mat was not strong enough to take the weight of the transport trucks. In these areas, a reinforcing mat was used as the foundation for the road. Its puposes were: to separate poor subsoil from the compacted fill; to act as a base for the compaction of the fill; to act as a filter, allowing the water to escape from the compacting subsoil, and to add tensile strength. This material is sold under a variety of brand names, and has gained wide acceptance for construction on soft soils.

Two widths of 3.8 m fabric were layed with an overlap of approximately 1 m, for a total width of 6.6 m. The road fill was spread over the fabric and directly on the bog to make a road 7.9 m wide. This worked reasonably well on shallow, flashet-free bog. In other areas it was necessary to corduroy the road with wood poles. Considerable settling was observed in some spots before the road stabilized; in a few others, total displacement of the peat occurred.

**Bridge Construction**

Bridges were required at the ends of alternate fields as shown on the mine plan. At the bridge location, a perforated plastic pipe of six inches diameter was layed in the bottom of the field ditch, and surrounded with a layer of moss peat. The bridge was then completed by backfilling with either moss

or fuel peat from the immediate vicinity.

The bridges were generally 20 m wide. This allowed the equipment to turn as the bridge was crossed. The bridges were placed so that the perforated pipe on the downstream side was within a metre of the perimeter ditch. This allowed the ditch to be cleaned out without the bridge having to be removed. The bridges did have to be taken up to deepen the field ditches. The bridges lasted about two years without needing major attention.

**Storage Areas**

The mining methods also determined the location of storage areas at distances of not more than 800 m from any point on each field. Finnish experience had shown this to be the maximum desireable distance for a wagon full of peat to have to travel. The areas were approximately 60 m square, about half the size used in Finland.

To prepare a storage area, a trench was cut around the designated space to the same depth as and connected to the perimeter ditch. Smaller ditches were cut across the area at 10 m intervals, graded to drain it. Perforated pipe was then layed in these ditches, and the storage area covered with waste material from the fields.

## BOG PREPARATION

**Sequence**

Once the ditches were cut and the other site preparations made, work began on preparing the bog for harvesting. The sequence of activities was:

tree removal
brush cutting
rotovating (or rototilling)
screw-levelling
profiling
flashet filling.

Naturally, this reflects the sequence for any one part of the mine. Activity was taking place in several areas at once, at different stages of preparation.

**Tree Removal**

The number of trees growing on Newfoundland bogs varies widely. High Point bog had trees only near the edges and in small patches in the middle. Trees did not therefore pose a significant problem.

When tree removal was required, it was accomplished by pulling the trees out using chains attached to rubber-tired tractors. This successfully removed the roots as well, but was very slow and labour-intensive. Three men were required, including the tractor operator. Altogether, about one hectare was cleared of trees in a month by nine men with three tractors. It would generally be advisable to avoid bogs with significant tree cover.

**Brush Cutting**

The low brush found on the bog, locally called "Labrador tea" or "Goaty", had to be cut prior to the rotovating. A standard farm brush cutter was used, which was similar to a rotary lawnmower. It was attached to the three-point hitch of a 50 HP tractor equipped with dual wheels. The cutter reduced the brush to tiny pieces which could be handled by the other equipment in the same manner as the peat.

**Rotovating**

Rotovating was done with a standard farm rototiller attached to a 70 HP tractor. The depth was set so that the surface mat was mixed with some of the peat below. Those areas where the peat was originally exposed did not require rotovating.

The rotovator blades had to be kept very sharp. Blunt blades collected too many roots, which twisted around the machine shaft.

It was considered unlikely that a rotvator wider than the 2 m machine used would have been more efficient. A larger tractor would have been required, and it is doubtful that the surface mat would support such a machine.

**Screw Levelling**

Bogs naturally have mounds and valleys. The screw leveller redistributed rotovated material across a four metre swath to make the field as level as possible.

The screw leveller was an attachment pulled by a tractor, and had three independent hydraulic levelling controls. Since most tractors have only two hydraulic outlets, a third had to be added. A 60 HP, four-wheel drive tractor with dual wheels front and rear was considered the most suitable.

The active part of the leveller was positioned about 5 m behind the tractor. This exaggerated problems caused by the deeper flashets in the bog, and resulted in a wavy surface. This was solved by filling the deeper holes before levelling, which slowed operations by up to a factor of ten.

**Profiling**

To accelerate run-off of snow melt and spring rains, the fields were profiled after the levelling stage. The same screw leveller was used, but set up at an angle to grade the field. The unit was run first along the ditch sides of each field, in opposite directions for each side. Then two inside runs were made, to produce a final profile with the centre of the field highest, sloping gradually toward the ditches on each side.

Producing an acceptable profile required at least six passes of this sequence. Furthermore, where the fuel peat was on the surface, the field had to be rotovated again between the levelling and profiling activities, since the screw leveller could not cut the fuel peat.

As long as the later harvesting activities were done uniformly over the field, the first profile lasted acceptably over the life of the project.

**Flashet Filling**

Like most bogs in Central Newfoundland, High Point had many flashets. Of the fifty fields ditched, less than 10% were entirely flashet free. These flashets caused numerous problems for the equipment used in bog preparation, and filling the flashets was an ongoing activity in the bog preparation phase.

Several techniques were used to fill flashets. Material in the vicinity was pushed in from the sides with the screw leveller and a front-end loader; material was brought from other areas and dumped in; and material was collected in a windrow and pushed into the flashet with a crawler tractor after freeze-up. This latter method proved to be the most successful.

## MINING METHODS

**Sequence**

Once the basic site and bog preparation were complete, the actual mining activities began. This stage was reached in the spring of 1981. The mining activities are comprised of:

Milling the surface layer
Harrowing the surface layer
Ploughing into ridges (Haku method only)
Loading (by vacuum or from ridge)
Transport to storage area and dump.

Although described as one sequence, this does not convey the exact way the activities were carried out. For every time a field was milled, it was harrowed several times. This was to obtain a top layer dry enough to be harvested: the variation was due to differing weather conditions.

**Milling**

The milling of peat is a process in which a thin layer of

peat is cut loose from the peat body. This thin layer fluffs into a loose thick layer which has no bond to the main body and therefore has no capillary action keeping it saturated. Consequently it dries over time, provided the weather remains dry.

Milling was carried out using standard farming equipment. The main implement used was a screw miller, but a spoon harrow and a rotovator were also used experimentally. No significant improvements were observed. Both two- and four-wheel drive tractors were employed. Again, the performance seemed comparable.

**Harrowing**

Some time after milling, the field was harrowed. Harrowing turns over the drying top layer to expose the lower part to the air, thus promoting the drying. Harrowing was done two, three or four times per milling, depending on the prevailing weather conditions.

Another standard farming implement, a spoon harrow, was used for this process. Three tractors were tried again, and performances were approximately the same.

**Ridge Ploughing**

With the Haku ridge-harvesting system, an extra step was involved. This step was the ploughing of the dried surface peat into windrow ridges in the centre of each field. It was done using a special 5 m plough blade, somewhat like a grader, attached to the front of a tractor. Two- and four-wheel drive tractors were used. Their performances were about the same.

**Ridge Harvesting**

The ridge harvesting unit was designed in Finland. Drawn behind a tractor, it picked up the peat ridge from the centre of one field and transferred it by a long conveyor to a wagon being pulled along the centre of the next field (see photographs in Appendix K). Two different tractors were used

to pull the unit, working in combination with one or two wagons and their tractors. The results are shown in the next chapter.

**Vacuum Harvesting**

The Vacuum harvesting unit was a self-contained system which required only one tractor. The dry layer of peat (ridging was not required) was simply picked up by the vacuum head as the harvester moved along the field. The peat was settled out in a cyclone, from where it fell into a storage tank below (see photographs in Appendix K). When the tank was full, the unit was pulled to the storage area, where the tank was side-dumped at the stockpile.

Both the driving speed and the vacuum power were adjustable, which made this system quite adaptable to changing conditions. If a few days of fine weather were forecast, a thick layer of peat was milled and harrowed, and harvested in one sweep. If the dry period was expected to be short, a thin layer was harvested. Alternatively, the dry top of a thick layer could be collected if rain threatened at short notice.

Originally designed abroad, the vacuum system is now manufactured in Canada. In other provinces, it is used for harvesting horticultural peat. It was found to be equally suitable for fuel peat during the project.

**Storage**

The peat was stockpiled at the storage areas created around the mine site. As it was dumped, it was pushed into conical piles with either a front-end loader or a wide-tracked crawler tractor. The purposes of piling it in this manner were: to increase the bulk density, thus speeding the loading onto the trucks; to reduce the surface area and lower the re-absobtion of water from the air or from rain; and to reduce the risk of self-ignition within the peat.

**Transportation** The transportation of the peat from High Point bog to the Abitibi-Price mill in Grand Falls required careful consideration and planning to protect both the peat and the environment. Being a small-scale, short-term project, the investment for special closed vans, as used in Finland, could not be justified. A local trucking firm was able to supply an 8 m self-dumping trailer with sides extended upward, but this proved to be inefficient and expensive. Severe problems were encountered with the rear dumping system when the peat was wet or frozen.

In 1982, a similar trailer was equipped with a vibrator. This shortened the unloading time considerably, but the moisture content was much lower when loaded compared to 1981, and the trucking was completed before the onset of freezing weather.

Tarpaulins used to cover the peat in the trailer prevented any dust problems. Although this increased the turnround time, it was a requirement of the Departments of Highways and Environment.

Loading was done with a front-end loader eqipped with a 3 $m^3$ bucket. This was a slow process as the loading ramp was high, in order to clear the sides of the trailer, and steeply inclined. The high bulk density of the fuel peat caused some problems for the lightweight loader being used.

**Storage at the Mill Site** At the Abitibi-Price mill, the peat was stored on a paved area which had very little provision for drainage. Thus whenever there was heavy rain, the peat absorbed considerable moisture. This was a particular problem in 1981.

The high winds experienced that same year did not cause any problems with the stockpiled peat. However, problems were experienced when loading in high winds. Airborne particles collected on and blocked the radiator of the loader. No fires

were experienced in the large stockpiles. One small fire did start in a pile at the mine site, but this was attributed to ignition of small particles by the exhaust of a nearby engine, rather than to spontaneous ignition.

The problem of moisture reabsorbtion during storage was greatly reduced in 1982 by shortening the storage time considerably.

# RESULTS

## SITE AND BOG PREPARATION

**Activity Rates**

Table 2 presents the results of data collected on the initial preparation activities. These took place during the summer of 1980 and the winter of 1980/81.

**Table 2. Site and Bog Preparation Activity Rates**

| Activity | Rate | Equipment | |
|---|---|---|---|
| | | Tractors | Personnel |
| Ditching | | | |
| Disc Ditcher | 260 m/hr | 1 | 1 |
| Backhoe | 8 m/hr | 1 | 1 |
| Brush Cutting | 4 ha/day | 1 | 1 |
| Rotovating | 5 ha/day | 1 | 1 |
| Screw Levelling | 2 ha/day | 1 | 1 |
| Profiling | 2 ha/day | 1 | 1 |
| Construction | no data | | |
| Tree Removal | 1 ha/mo | 3 | 9 |
| Flashet Filling | no data | | |

These data should be interpreted carefully, according to the comments which follow. Details of the derivation are in Appendix F.

**Ditching**

Two main ditching systems were employed: a disc ditcher and a backhoe. The disc ditcher was very efficient, operating at rates up to 400 m/hr. though it must be remembered that three cuts were needed to complete the field ditches. Also, the disc ditcher was not appropriate for the main and perimeter ditches, as a larger cross-section was required.

**Brush Cutting**

This rate is that which should be achievable on a good day, by an experienced driver avoiding serious trouble with flashets.

**Rotovating** The same comments apply as with brush cutting. This activity was not required in areas where the peat was exposed.

**Screw Levelling and Profiling** The same comments apply as with brush cutting. Flashets were potentially more troublesome, since rotovating destroys the buoyancy of the surface mat. Deeper flashets needed to be filled before this activity. The rate may have been slowed by the use of a lightweight leveller, which could not move the fuel peat efficiently.

**Construction** Data were not collected on construction activity rates, though cost data are available. These activities are site-specific, and would need to be estimated anew for future projects.

**Tree Removal** This operation proved to be extremely time and labour consuming. It is quite site-specific, and in future projects could be avoided altogether, or at least minimized.

**Flashet Filling** This was another activity which was site-specific. It was also found that the best time to do it was after freeze-up. It is much easier if the flashets are flagged beforehand. Bogs which have very numerous large flashets would best be avoided.

## MINING ACTIVITIES

**Activity Rates** The rate data collected on the mining activities are presented in Table 3. On many activities, a number of equipment combinations were tried experimentally. Where different performances were observed, these are given. Details of the derivation are given in Appendix F. The different tractors used are identified as, for example, MF255/2 or MF285/4. This translates as Massey-Ferguson, model 255 with two-wheel drive, or model 285 with four-wheel drive.

| Activity | Rate | Equipment | |
|---|---|---|---|
| | | Tractor | Personnel |
| Milling | 6 ha/hr | MF255/2[1] | 1 |
| | 1.61 ha/hr | MF275/2 | 1 |
| | 1.58 ha/hr | MF285/4 | 1 |
| | 2.15 ha/hr | V160 | 1 |
| | 1.75 ha/hr | Average with std. eqt. | |
| Harrowing | 9.0 ha/hr | MF255/2 | 1 |
| | 10.9 ha/hr | MF255/4 | 1 |
| | 11.4 ha/hr | MF275/2 | 1 |
| | 9.1 ha/hr | Average with std. eqt. | |
| Ridging | 2.5 ha/hr | MF255/4 | 1 |
| Ridge Harvesting | 11.0 t/hr | 1 wagon (2 tractors) | 2 |
| | 16.5 t/hr | 2 wagons (3 tractors) | 3 |
| Vacuum Harvesting | 5.4 t/hr (avg) | 1 | 1 |
| | 6.3 t/hr (best) | MF275/2 | 1 |
| Bucket Loading | 13 t/hr | 2 + loader | 2 |

**Table 3. Mining Activity Rates**

Note 1. This was using the spoon harrow to mill. Other milling data were recorded using the screw miller.

The comments and observations which follow should be used to interpret the data in Table 3.

**Milling**

Although the spoon harrow showed a much higher speed in the milling operation than did the screw miller, this was the average of only two trials; regular performance may not be so superior. All the rates included a range of depths of mill. No tests for optimisation were carried out, since weather

forecasts were an uncontrollable factor.

**Harrowing**

The data for the Massey-Ferguson 255/2 were analysed in some detail. What appeared to be erroneous results were removed, to attempt to derive a "steady-state" production figure. This turned out to be 7 ha/hr overall, or 9.8 ha/hr for any production period of more than three hours.

**Ridge Ploughing**

The data for ridge ploughing were very variable. Consequently, the final figure quoted may not prove extremely reliable in practice. The cause of the variation was not isolated.

**Ridge Loading**

The rates given are based on the "steady-state" production figure for the MF285/4 attached to the ridge-loader. The difference between the rates for one wagon or two are, to an extent, theoretical, since the data collected showed no significant difference. However, since the rates quoted are based on a reasonable amount of data, they should be realizable under optimal conditions.

Why no difference was found was not finally established. It was suspected that there were two controlling factors: the size of the ridge, and the relative postions of the working area and the stockpile area. It was found that the optimum size of ridge for the ridge loader was quite small, though actual dimensions were not quantified. Large ridges tended to slow the loading process, which nullified the benefits of using two wagons.

A similar effect was apparent when the loading activity was close to a storage area. The unloading cycle of the wagons was shortened to the point where they would be waiting for each other at the ridge loader, thus again nullifying the benefits.

There is one other consideration in the decision as to whether one or two wagons should be used. With one wagon, if the tractor pulling it should have trouble, the ridge loader would be held up, whereas with two wagons, it could continue working. Conversely, trouble with the loader or its tractor would hold up either one or two wagons and tractors.

**Vacuum Harvesting**

As with the other activities, the data on vacuum harvesting were dependent on many variables and errors. The number of observations was small, and a "steady-state" rate was not established. The figures quoted are the simple averages.

**Bucket Loading**

This activity was simple loading from the ridges using a front-end loader. It was tried experimentally a few times, therefore the data are not extremely reliable. The average rate slightly exceeds that of the ridge loader.

There are some other operational advantages of using a front-end loader. It was not sensitive to twigs and roots, and could handle a larger ridge than the ridge loader. Also, the time for connecting the ridge loader to its tractor was avoided, as would be the capital cost of the ridge loader (a front-end loader was required anyway). Furthermore, one less tractor would be required for the harvesting operation. The major disadvantage would be that other operations, for which the front-end loader was required, may be held up. These activities included truck loading. Nevertheless, this method was considered preferable under certain circumstances.

## TRANSPORTATION ACTIVITIES

**Within the Mine Area**

On occasion, it was necessary to move the stockpiled peat from one location to another (for example, to where it could be loaded onto the transport trucks). This was achieved using the front-end loader and the wagons used for ridge harvesting.

The rates achieved were 9.1 t/hr using one wagon, and 13.7 t/hr using two wagons. This applies to moves of 400 to 500 m, which were typical.

**Transport** The average time to load a truck was thirty minutes, including the necessary activities of removing sticks and backdragging.

## MACHINE UTILIZATION

**Overall Utilization** It was difficult to quantize the available information on the machine utilization. Only gross figures were accessible. The overall utilization of the four principal tractors during the main season was 22.75%. The highest rate for a single machine was 26% for the MF285/4

**Repair Time** The repair time was probably greater than would be the case in a full-scale commercial operation, due to the lack of a large inventory of spare parts and on-site shop facilities. Much of this work was done on the field. The scale of the exaggeration due to these factors was not estimable, but a guide may be that from August 1 to September 2, 1981, two repairs necessitated 129 hours of downtime and repairs, or 24% of total machine time.

## TOTAL PRODUCTION

**1981 Season** Delivery from High Point bog to the Abitibi-Price paper mill in Grand Falls for the 1981 production took place between the end of September and mid-November, the peat having been stockpiled at the mine site durng the harvesting season. The total delivery was 566.2 tonnes, at an average moisture content of 59.7%. This corresponded to 227 tonnes of dry peat. The moisture content of the deliveries tended to rise during the period, due to heavy rainfall on the uncovered stockpiles, both at the mine site and at the mill.

**1982 Season** Shipping to the mill was done earlier during the 1982 season, to avoid the reabsorbtion of moisture which occurred the previous year. In all, 1164.5 tonnes were shipped, at an average moisture content of 43.9%, corresponding to 653 tonnes of dry peat.

## USE OF PEAT AS FUEL

**Initial Trials** Abitibi-Price became interested in the use of fuel peat for process steam generation due to the high cost of oil. It was believed they could burn peat in an an existing boiler which was already in use for bark and wood chips, mixed with oil.

Based on the original laboratory tests, it was estimated that an annual production of 87,000 tonnes could replace approximately five million gallons of fuel oil. This corresponds to a daily consumption of 260 tonnes for eleven months of the year. About 800 ha of productive bog would be needed to sustain this rate.

Inital trials in New Brunswick, done in 1979, indicated that the pneumatic infeed system at the Grand Falls, Newfoundland, mill was capable of handling peat. Some pulsing occurred in the boiler, but was considered not serious enough to interfere with the project.

The first test burn was carried out on October 1, 1981, using peat delivered to the mill over the previous month, mixed with bark and woodchips. The only problem experienced was a minor one of some roots getting caught in the feed system. The peat was then burned as delivered until early November, when the moisture content rose above 60%, due to heavy rainfall.

**Test Burning** A controlled test burn was carried out on October 28. Peat with a moisture content of 62.8% was mixed with bunker C oil

as required to maintain the combustion process. The results were:

| | |
|---|---|
| Duration of trial | 5 hours |
| Peat burned | 90 tonnes |
| Moisture Content | 62.8 % |
| Steam produced | 140,616 kg |
| Maximum rate | 29,484 kg/hr |

Some running adjustments were made during the trial. The air pressure on the pneumatic feed was reduced from 76.2 to 38.1 mm (30 to 15 in.) to allow the peat to discharge softly across the grate, and to reduce turbulence in the burning area. Also, the air damper to the pinhole, which feeds air to the grates, was reduced to 20% open. It is left completely open when bark is burned.

Boiler operation was satisfactory, with no pulsing. However, it was observed that the boiler capacity could not be satisfied, even though the gate on the reclaim conveyor was open fully, and the chain operating at maximum speed. Again, some clogging of the feed chutes were caused by long tree roots. These could have been removed during the drying period on the field, but the problems at the boiler were not foreseen. It was also observed that the coating of the grates was more with peat than with bark and chips.

It was estimated that, had the moisture content of the peat been lowered to 50%, steam production would have been 208,656 kg, or 40824 kg/hr, a more satisfactory result.

Apart from the controlled test, 400 tonnes of peat were burned during October 1981. It was mixed 1:1:1 with bark and woodchips. This mixture was observed to burn well, without oil. A record steam production from "refuse" was obtained of 66,800,000 GJ, or 39,197 kg/hr.

**Replacement of Oil**

Bunker C oil, the fuel used by the mill, contains in theory 6720 x $10^6$ Joules per barrel (159 L). The normal efficiency achieved in the Number 4 furnace at the mill is 85%, or an effective yield of 5712 x $10^6$ Joules per barrel. The steam production achieved in the test burn was calculated to have required 5840 x $10^6$ Joules per tonne of peat. This meant that a tonne of peat, as burned at 63% moisture content, was equivalent to 1.02 barrels of fuel oil.

If the peat had been burned at 50% moisture content, a yield of 7850 x $10^6$ Joules per tonne should have been achieved, equivalent to 1.37 barrels of fuel oil per tonne of peat.

## ENVIRONMENTAL IMPACT

**General**

Peatlands provide a habitat for many wildlife species. The large scale development of such areas for both agricultural purposes and fuel peat production could seriously affect the survival of those species. Furtheremore, the drainage of peatlands may also affect the hydrological regime and water quality in the surrounding area. At present, there is a lack of information on the environmental consequences of peatland development.

The large scale burning of fuel peat could also create problems. Fly ash deposition in the locality of the plant, the release of heavy metals from the organometal complexes of the peat, and the disposal of residual ash must also be considered.

**Monitoring Program**

The Provincial Department of Mines and Energy provided funds for the environmental monitoring of the Bishop's Falls project. This program consisted of the following operations:

1. Weather Station. Supervised by the Atmospheric Environment Service. Data were collected on wind, temperature, and precipitation.

2. Hydrology. Supervised by the Newfoundland Department of the Environment. Facilities used were wiers at two stations on the drainage channels, and a series of piezometers.

3. Wildlife Monitoring. Carried out by the Department of Culture, Recreation and Youth.

4. Water Quality. Supervised by the Environmental Protection Service. Daily measurements were ph, Do, temperature and alkalinity. Turbidity, suspended solids, nitrates, nitrites, T.O.C., and a series of heavy meatls were measured weekly.

5. Emissions. Supervised by the Newfoundland Department of the Environment. Particulate emissions were measured in the vicinity of the test burns.

**Results**

No serious environmental effects were found. Analysis of water samples from a stream receiving water from the bog showed that ph (alkalinity), specific conduction, and hardness (calcium and magnesium) all declined immediately below the inflow from the bog, but values returned to normal 1.3 km downstream. Levels of nitrates, turbidity, suspended solids, toal organic carbon, and barium increased immediately downstream of the bog inflow, but approached background levels at the downstream station. Levels of iron and aluminum downstream from the bog inflow were intermediate to values from the other stations, and were highest at the downstream station.

Data collected in the first year of sampling indicated that

all meatals, with the exception of iron, were near the limit of detection. Thus it appeared that the leaching of heavy metals from bogs may not be a problem. The results of testing during the 1980 season are presented graphically in Appendix G.

## COST-BENEFIT ANALYSIS

### COSTS

**Bog Preparation**

In establishing a commercial-scale operation to mine fuel peat, the preparation costs would be a once-only item, and consequently would be quite low in relation to the overall cost of producing the fuel. On the other hand, this expenditure would occur some time before revenues began to flow, and so would be of reasonable interest.

To quote the actual costs incurred in the demostration project would be of purely academic interest, for two reasons. Firstly, many experimental methods were tried, with both equipment and techniques, and everyone involved was undergoing a learning experience. Secondly, these costs are, to a very large extent, site-specific. Much could be done to minimize them by bog selection, mine plan, and seasonal scheduling. The appropriate best options for these factors have already been discussed.

It was estimated that, using the lessons learned from the development project, a commercial scale operation would require about $3000 per hectare to prepare a 100 ha fuel peat mine. This includes access roads, ditching, storage area and bog road construction, tree removal, flashet filling, brush cutting, rotovating, levelling and profiling. An office and garage would add about $80,000 to this total. To reduce capital outflow in the initial year, all this activity could easily be done by contracted services.

**Mining**

A considerable amount of data was collected over the two years of harvesting activity. From these data, detailed costs were developed for the harvesting activities. The basis for these costs is given in Table 4. The resulting costs are presented in Table 5.

| Factor | Rate |
|---|---|
| Labour - Production | $ 7.80/hr (incl. benefits) |
| - Repair | 10.20/hr (incl. benefits) |
| Parts | 3.56/hr of machine time |
| Repair time | 3.82/hr of machine time |
| Maintenance | 0.34/hr of machine time |
| Combined weighting | 7.72/hr of machine time |
| Fuel - MF285/4 | 3.00/hr of machine time |
| - other machines | 2.40/hr of machine time |

**Table 4. Basis of Production Costs**

Thus the cost of an operation could be calculated as:

Cost = Machine time x ( $2.40* + $7.72 )
+ Labour time x $7.80

* $3.00 for MF285/4

| Activity | Cost | Frequency |
|---|---|---|
| Milling | $ 11.28/ha | 1.07 per ridging |
| Harrowing | 1.95/ha | 3.8 per ridging |
| Ridging | 7.82/ha | |
| Harvesting[1] | | |
| Ridge | 7.27/t | .3 t/ha/ridging |
| Vacuum | 6.08/t | |

**Table 5. Summary of Costs in 1982**

Note 1. These are total production costs.

**Transport Costs** The cost for loading the peat onto the transport trucks was calculated as $0.76 per tonne.

Transportation was carried out as a contracted service, and the rates charged varied. As a guide, the average price for transporting the peat over the 20 km trip to Grand Falls was approximately $7.00 per tonne, including offloading time. The distance-cost relationship would not be completely linear, due to the loading and unloading time involved.

**Total Costs**

To produce the 1164.5 tonnes of fuel peat delivered during the 1982 season, the total direct costs, excluding any administative or other overhead costs, was $17500.73, or a cost of $15.03 per tonne, delivered. This could have been reduced to $13.84 per tonne if vacuum harvesting had been usd throughout, according to calculations made comparing the two harvesting methods.

Details of the derivations of costs are in Appendix F.

## BENEFITS

**To The Project**

Abitibi-Price paid $25.00 per tonne delivered. Therefore the net income after direct costs was $9.07 per tonne, using ridge loading. This could have been $11.16 per tonne using vacuum harvesting.

**To the Customer**

The energy value of the 90 tonnes of peat burned during the controlled burn was equal to 91.8 bbl of Bunker C oil, which would have cost the company $2717.28. The peat cost was $2250.00, so the company saved $5.19 in oil on every ton of peat burned. If it had been possible to maintain the moisture content of the peat at 50%, the saving would have increased to $15.52, or just over 50% of the oil cost.

Abitibi-Price burns approximately 350,000 barrels of Bunker C oil annually. Replacing half of this with 125,000 tonnes of fuel peat at $25 per tonne would save the company about $2,000,000. This would require approximately 1150 hectares of producing bog.

These figures for potential savings to the customer do not take into account the extra expense of handling the peat at the plant. These costs were not evaluated, but for comparison, the handling cost of woodchips was estimated in 1979 to be $1 per green ton.

**To Government** The current level of subsidy on Bunker C is $xx.xx per barrel. This would be the direct financial saving to government. The indirect benefits would stem from retaining the cost of the oil in the Canadian economy, and from reduced unemployment through the harvesting activity.

**Cash Flow** Although the $10.00 per ton operating profit appeared reasonable, setting up a commercial operation would require quite a high initial investment, both in capital and development costs. Consequently, the cash flow of such an operation was modeled on a computer for the life of a mine, to evaluate the overall return on investment. The parameters and assumptions for the analysis were as follows:

**Timescale** The life of the project would be 17 years. Year 1 would be for bog development. Year 17 would be a winding up period. The would be no sales in either of these years. Full production would be achieved in year 2, and continue at a constant annual rate up to the end of year 16, with some specific exceptions.

**Selling Price** The delivered price is $25.00 per tonne, at a moisture content of 50%

**Costs.** The direct production cost is $8.03 per tonne. The transportation cost ia $7.00 per tonne.

**Equipment.** Tractors, loader and implements are purchased in year 2, and replaced in their 9th year at their full initial cost. All equipment is sold in the 17th year for the undepreciated capital cost.

**Scale of Operation.** The mine would be 100 ha, producing a maximum of 19,200 tonnes per year.

| Year's Use | Trade-in Value (% of purchase price) |
|---|---|
| 4 | 25 |
| 5 | 20 |
| 6 | 15 |
| 7 | 10 |
| 8 | 5 |

The total net cash flow was calculated as follows:

| | |
|---|---|
| | Gross Revenue (including year 17 value) |
| minus | Total variable and quasi-variable costs |
| = | Net operating Revenue |
| minus | Capital cost allowance |
| = | Taxable income |
| minus | Tax payable |
| = | Net income or profit |
| plus | Capital cost allowance |
| = | Net operating cash flow |
| minus | Capital outlay |
| = | Total cash flow |

If the taxable income was negative in any year, tax payable in that year was assumed to reduce capital outflow, since it would result in a tax saving when the owners applied it against income from other sources.

Details of the cash flow calculations are given in Appendix H.

The outcome of the cash flow calculations with the standard values described was a return on investment of 0.23% per year. Table 6 shows the sensitivity of this result to a variety of values for yield, price received, and transportation costs.

| Yield t/ha | Price Received $/t | Transportation Costs $/t | Rate of Return on Investment % per year |
|---|---|---|---|
| 192 | 25.00 | 7.00 | .23 |
| | | 6.00 | 2.75 |
| | | 5.00 | 5.12 |
| | | 4.00 | 7.34 |
| 192 | 26.50 | 7.00 | 3.33 |
| | 27.50 | | 6.21 |
| | 28.75 | | 8.93 |
| 202 | 25.00 | 7.00 | 1.52 |
| 212 | | | 2.77 |
| 222 | | | 3.98 |
| 192 except 96 in yrs. 6 & 11 | 28.75 | 4.00 | 12.95 |

**Table 6. Rate of Return Sensitivity**

**Socio-Economic Impact**

Although a 100 ha mine was used for the cash flow analysis, there was potential in the region of the demonstration project for a 600 ha operation to be created. Should this occur, there would be a substantial positive socio-economic impact on the area, paticularly on the towns of Bishop's Falls, Grand Falls, and Windsor.

A development period of three years would be required, with 200 ha coming into production in each year. The life of the operation would be in the order of 20 years.

**Direct Employment.** After the development period, there would be a total of 40 direct jobs, of which 35 would be seasonal. These would last for about 8 months of the year, thus generating 23 man-years of employment per year. These employees would mostly be resident in the region.

Direct employment would inject about $11,000,000 into the local economy over the life of the mine, reaching approximately $500,000 per year by the 4th year. It would

increase by 8% the following year, and then remain constant.

Details of the specific jobs that would be created are in Appendix I.

**Indirect Employment.** Most of the specialized equipment would have to be brought into the area. However, fuel, repair services and some spare parts would be purchased locally, to the amount of $200,000 over the mine life. This would stimulate employment in these sectors. Also, trucking would continue to be contracted. It was estimated that three full-time truck driving positions would be generated after the 3rd year, injecting a further $500,000 per year into the local economy.

**Disposal of Income.** Over the 20 year period, the disposable income of mine employees would total $8,500,000. Using Provincial norms, this would generate income for other idustries as follows:

| | |
|---|---|
| Food retail | $2,000,000 |
| Housing | $1,000,000 |
| Transportation | $1,000,000 |
| Clothing retail | $ 500,000 |
| Automobile retail | $ 500,000 |
| Recreation | $ 500,000 |

**Government Revenue.** It was estimated that the Federal Government would gain $1,130,000 in income tax, with a further $660,000 going to the Province. Residential prpoerty and water taxes would yield $370,000 to local government, Sales and other taxes would be additional to these amounts.

# CONCLUSIONS AND RECOMMENDATIONS

## CONCLUSIONS

**Feasibility**

It was concluded that it is feasible to mine fuel grade peat in Newfoundland, and to use it to replace imported fuel oil in the industrial and utility sectors of the Provincial economy. It was learned that moisture reabsorbtion can be a major problem, but that minimizing storage time and handling could alleviate this. The fuel replacement potential of the peat mined during the project was 1.37 barrels of Bunker C per tonne of peat at 50% moisture content, or 7850 x $10^6$ J.

**Equipment Capabilities**

Existing peat mining equipment proved quite suitable for working on Newfoundland bogs, provided that care is taken in certain aspects. These include bog and mine site selection to avoid trees and flashets as much as possible, and timing some activities for certain seasons, such as field ditching and flashet filling in the winter months. Both the Haku ridge-loading system and the vacuum harvesting system worked, with the vacuum system having a 16% cost advantage. Ridge loading by means of a front-end loader also proved practical.

Transportation was not as successful as it might have been. Loading the high sided trucks used was difficult with the rudimentary facilities constructed, and the trucks themselves were not perfectly suited. The enclosed vehicles used in Finland would have been better. One of the major problems was unloading wet or frozen peat from the rear-dumping trailer.

**Storage and Handling Facilities**

The facilities at the paper mill were not adequate. The undrained, paved, storage area resulted in a lot of water being reabsorbed by the peat, especially in the year that it was stockpiled for some time. This resulted in the moisture content being high enough to impair the heat value of the peat seriously when it was burned. The actual burning systems

in Abitibi-Price's Number 4 furnace worked quite adequately with the fuel peat in combination with bark and woodchips.

**Cost Data**

Fuel peat can be produced in Newfoundland for $7 to $8 per tonne, FOB at the mine site. Transportation adds another $7 per tonne for approximately 20 km. Bog development costs would be in the order of $3000 per hectare for a commercial scale operation, excluding road construction. Capital cost for equipment would be approximately $340,000. This equipment should have a useful life of about seven years.

Despite a reasonable gross profit on the sale of the peat, the high front-end capital outlay resulted in a very low return on investment when a commercial scale operation was modeled. Increasing the selling price by up to 20%, or reducing transportation costs by 50% would greatly improve this result. Another route to improving the viability would be special assistance with the development or capital costs, to reduce the debt-funding load.

**Comparison With Finnish Operations**

Generally, the results achieved compared reasonably well with existing operations in Finland, given that this was a demonstration project. An itemized comparison is presented in Appendix J.

## RECOMMENDATIONS

Under present conditions of oil prices, interest rates and operating costs, the mining of fuel peat for the Newfoundland commercial and utility industries cannot be recommended as a viable proposition for the private sector.

## GLOSSARY

**Blanket Bog.** A British term for bog covering undulating semiuplands. Bogs of cool temperature regions formed under a maritime raainfall at lower elevations. Bogs on hills developed under high rainfall and lower temperatures.

**Bog.** Peatlands in which sphagnum peat predominates: can be tree-covered. Usually, peat layer is thick. Generally acidic and nutrient-poor. Sometimes used loosely to refer to raised bog peatlands.

**Boglands.** The initial stage of bog development which, depending on the environment, can last for different times. The root systems of plants in boglands are in or next to mineral soils.

**Bulk Density.** The total weight of a material per unit volume, including solid material and water.

**Energy Peats.** Peats with low ash content, high bulk density and a high degree of humification.

**Fen.** Open peatland, usually sedge-covered. Sedge peat predominates. Less acid than peat in bogs.

**Fibric.** The least decomposed of all organic soil materials. It has large amounts of well-preserved fibre that is readily identifiable as to origin.

**Humic.** The most highly decomposed of organic soil materials. It has the least plant fibre, highest bulk density, and lowest saturated water content. It is very stable, and changes little physically or chemically over time, in comparison to other grades.

**Humification, Degree of.** A 10 point scale of decomposition of peat, useful for field determination.

**Mesic.** Intermediate stage of decomposition between fibric and humic.

**Peat.** Partially decomposed plant matter containing not more than 40% mineral matter by weight. An internationally agreed definition is lacking.

**Peatland.** Land covered by peat. Characterized by a high water table.

**Peat Moss.** Peat consisting mainly of humified or slightly humified sphagnum.

**Raised Bog.** Bog with an elevated central area caused by peat accumulation. This central zone is generally isolated from the local water table and chiefly dependent on precipitation for water and minerals.

**Von Post System.** Originally a system for determining the degree of humification. Later expanded to include other characteristics, such as peat type, moisture content and fibrosity.

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# APPENDIX A

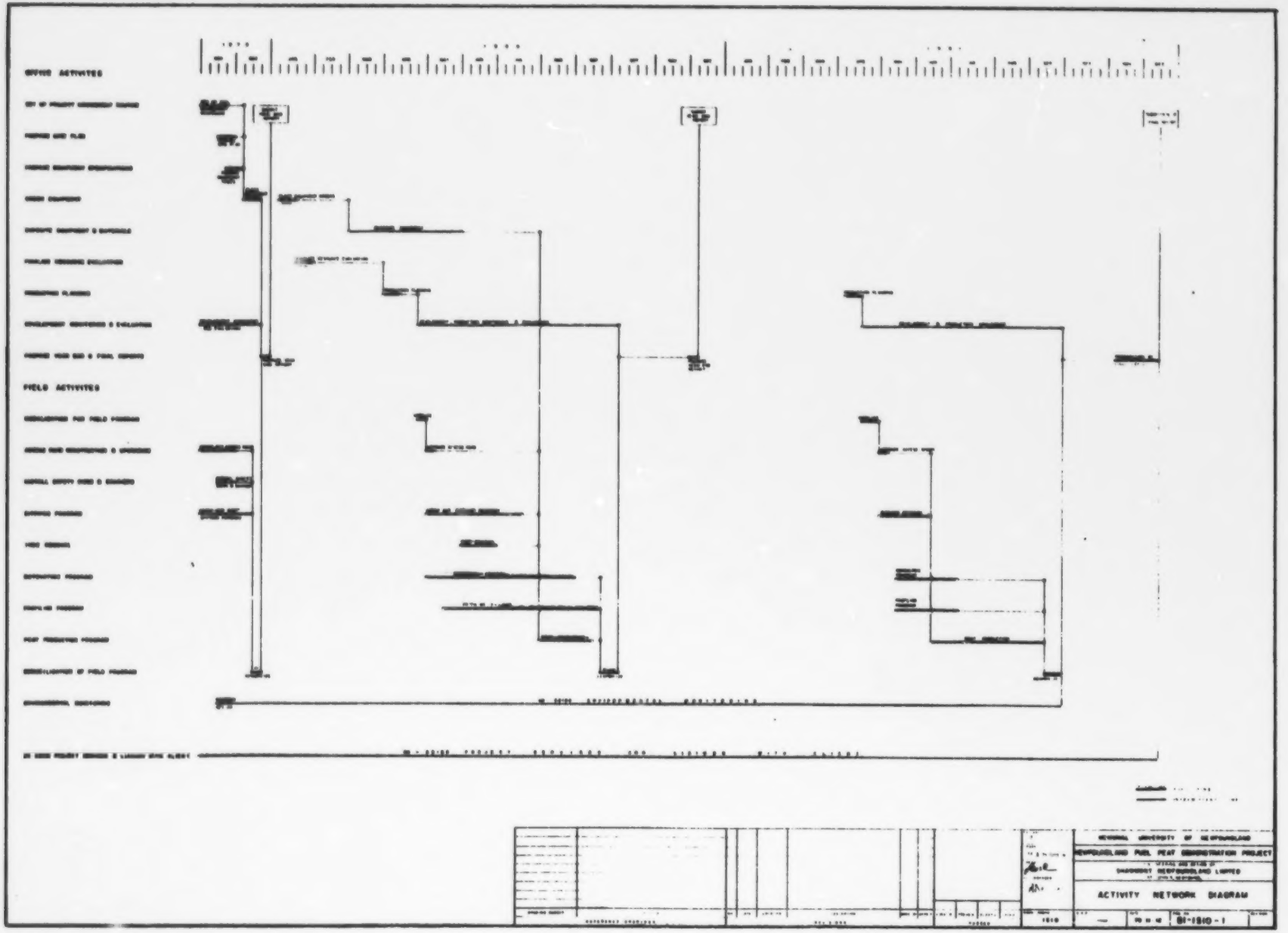
# PEAT TYPE CLASSIFICATION

## VON POST SCALE FOR PEAT CLASSIFICATION

| Classification | Description |
|---|---|
| H1 | Completely undecomposed peat which, when squeezed, releases clear water. Plant remains are easily identifiable, and no amorphous material is present. |
| H2 | Mostly undecomposed peat which, when squeezed, releases clear or yellowish water. Plant remains are still easily identifiable, and no amorphous material is present. |
| H3 | Very slightly decomposed peat which, when squeezed, releases muddy brown water, but no peat passes between the fingers. Plant remains still identifiable, and no amorphous material present |
| H4 | Slightly decomposed peat which, when squeezed, releases very muddy dark water. No peat passes between the fingers, but plant remains are slightly pasty, and have lost some of their identifiable features. |
| H5 | Moderately decomposed peat which, when squeezed, releases very muddy water with a small amount of amorphous, granular material escaping between the fingers. Plant remains are quite indistinct, although it is possible to recognize certain features. The residue is very pasty. |
| H6 | Moderately to strongly decomposed peat with a very indistinct plant structure. When squeezed, about 1/3 of the peat escapes between the fingers. The residue is very pasty, but shows the plant structure more distinctly than before squeezing. |
| H7 | Strongly decomposed peat, containing a lot of amorphous material with very faintly recognizable plant structure. When squeezed, about 1/2 of the peat escapes between the fingers. If any water is released, it is very dark and almost pasty. |
| H8 | Well decomposed peat with a large quantity of amorphous material,and very indistinct plant structure. When squeezed, about 2/3 of the peat escapes. A small quantity of pasty water may be released. the plant material remaining in the hand consists of residues that resist decomposition, such as roots and fibres. |
| H9 | Almost fully decomposed peat in which there is hardly any recognizable plant structure. When squeezed, almost all the peat escapes as a fairly uniform paste. |
| H10 | Completely decomposed peat with no discernible plant structure. When squeezed, all the peat escapes. |

# APPENDIX B

## ACTIVITY SCHEDULE




ACTIVITY NETWORK DIAGRAM

# APPENDIX C

# BOG RANKING SCHEME

## Bog Evaluation Criteria

Eight principal criteria were considered in evaluating the prospective sites. These are described below, with the values assigned in the evaluation matrix.

1. Ownership. It was considered desireable to have the mine site on Crown Land, since other ownerships could lead to protracted negotiations.

| | |
|---|---|
| Located on Crown Land | 4 |
| Located on a mining concession | 2 |
| Fee Simple or Reid lot | 0 |

2. Surface Area. Although 50 ha would have been sufficient, a greater area was preferred, to allow for future development.

| | |
|---|---|
| Area > 100 ha | 4 |
| 100 ha > Area > 50 ha | 2 |
| Area < 50 ha | 0 |

3. Accessibility. The minimum quantity of road construction was desired.

| | |
|---|---|
| Direct access | 6 |
| Access within 0.5 km | 4 |
| Access within 5 km | 2 |
| Access at more than 5 km | 0 |

4. Surface Water. Surface water is a good indicator of the drainage capability of the bog. The best potential drainage was desired.

| | |
|---|---|
| Ponding < 5% of area | 3 |
| Ponding between 6% and 15 % | 2 |
| Ponding > 15% of area | 1 |

5. Proximity to Plant. Haulage distance was considered important, but not vital.

| | |
|---|---|
| Less than 10 km distant | 3 |
| Between 10 and 20 km | 2 |
| Over 20 km | 1 |

6. Environmental Considerations. Proximity to populated areas, or drainage into Provincial parklands or town water supplies were considered undesireable.

| | |
|---|---|
| No obvious environmental problems | 3 |
| Located within 2 km of populated area | 2 |
| Located within parkland or water supply catchment area | 1 |

7. Resource Quantity. The demostration project had a planned life of 2 to 3 years, but bogs which could offer a greater longevity for the mine were preferred.

| | |
|---|---|
| Peat resource > $10^6$ $m^3$ | 3 |
| $10^6$ $m^3$ > Peat > 500 x $10^3$ $m^3$ | 2 |
| Peat resource < 500 x $10^3$ $m^3$ | 1 |

8. Moss Peat to Fuel Peat Ratio. A greater proportion of fuel peat was preferred. This was initially judged from aerial photo interpretation, but this was considered adequate for evaluation purposes.

| | |
|---|---|
| Moss/fuel peat ratio 1:1 (or less) | 3 |
| Moss/fuel peat ratio between 1:1 and 2:1 | 2 |
| Moss/fuel peat ratio greater than 2:1 | 1 |

The results of the evaluation are presented in the following table. It is important to note that because of its subjectivity, and the variability of the input data, this type of analysis has no absolute value. It can only be considered applicable in a comparitive sense.

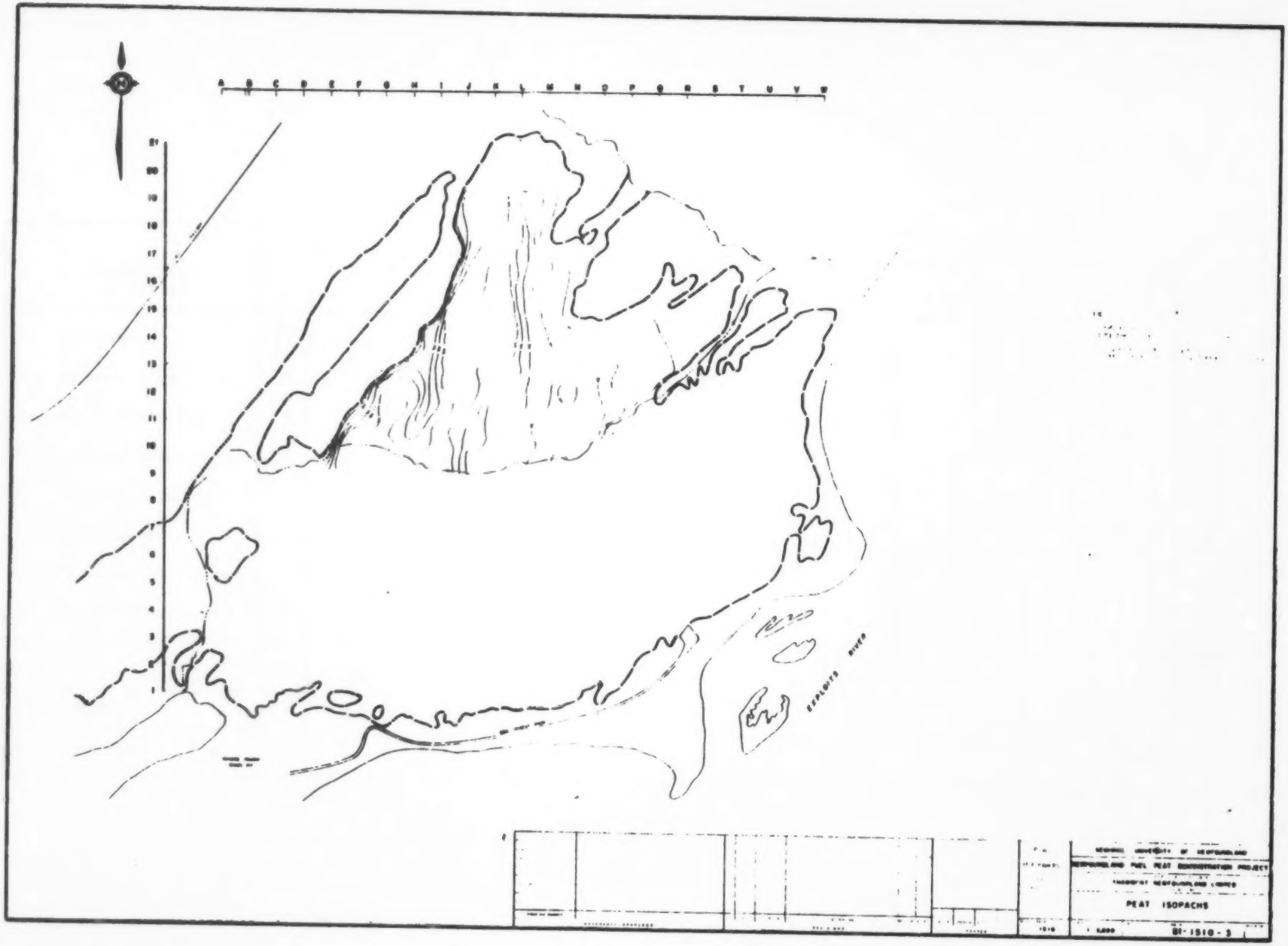
Of the five top ranking bogs considered as potential sites for the demonstration project, Bog 4 - High Point Bog - was recommended as the best choice. This bog was larger, appeared easier to bring into production, and had no obvious environmental drawbacks.

| EVALUATION CRITERION | BOG NUMBER | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| 1. Ownership | 2 | 4 | 4 | 4 | 4 | 2 | 4 | 4 | 2 | 2 | 2 | 2 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 2 | 2 | 4 |
| 2. Surface Area | 4 | 1 | 3 | 4 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 4 | 4 | 4 | 4 | 0 | 2 | 0 | 0 | 2 | 0 |
| 3. Accessibility | 4 | 6 | 2 | 6 | 6 | 4 | 4 | 4 | 4 | 2 | 2 | 1 | 1 | 2 | 0 | 2 | 4 | 2 | 2 | 3 | 0 | 4 |
| 4. Surface Water | 1 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 2 | 1 | 1 | 2 | 3 | 3 | 2 | 2 | 1 | 3 |
| 5. Proximity to Plant | 2 | 3 | 3 | 2 | 1 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 |
| 6. Environment | 3 | 1 | 2 | 3 | 1 | 1 | 1 | 1 | 3 | 2 | 3 | 1 | 2 | 3 | 3 | 2 | 2 | 1 | 3 | 2 | 1 | 3 |
| 7. Resource Quantities | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 1 |
| 8. Humification Ratio | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| Total | 21 | 22 | 20 | 25 | 20 | 17 | 19 | 18 | 18 | 15 | 16 | 14 | 18 | 19 | 17 | 19 | 18 | 17 | 16 | 13 | 12 | 19 |
| Final Ranking | 3 | 2 | 4 | 1 | 4 | 14 | 6 | 10 | 10 | 19 | 18 | 20 | 10 | 6 | 14 | 6 | 10 | 14 | 17 | 21 | 22 | 6 |
| Selected Bogs | * | * | * | * | * | | | | | | | | | | | | | | | | | |

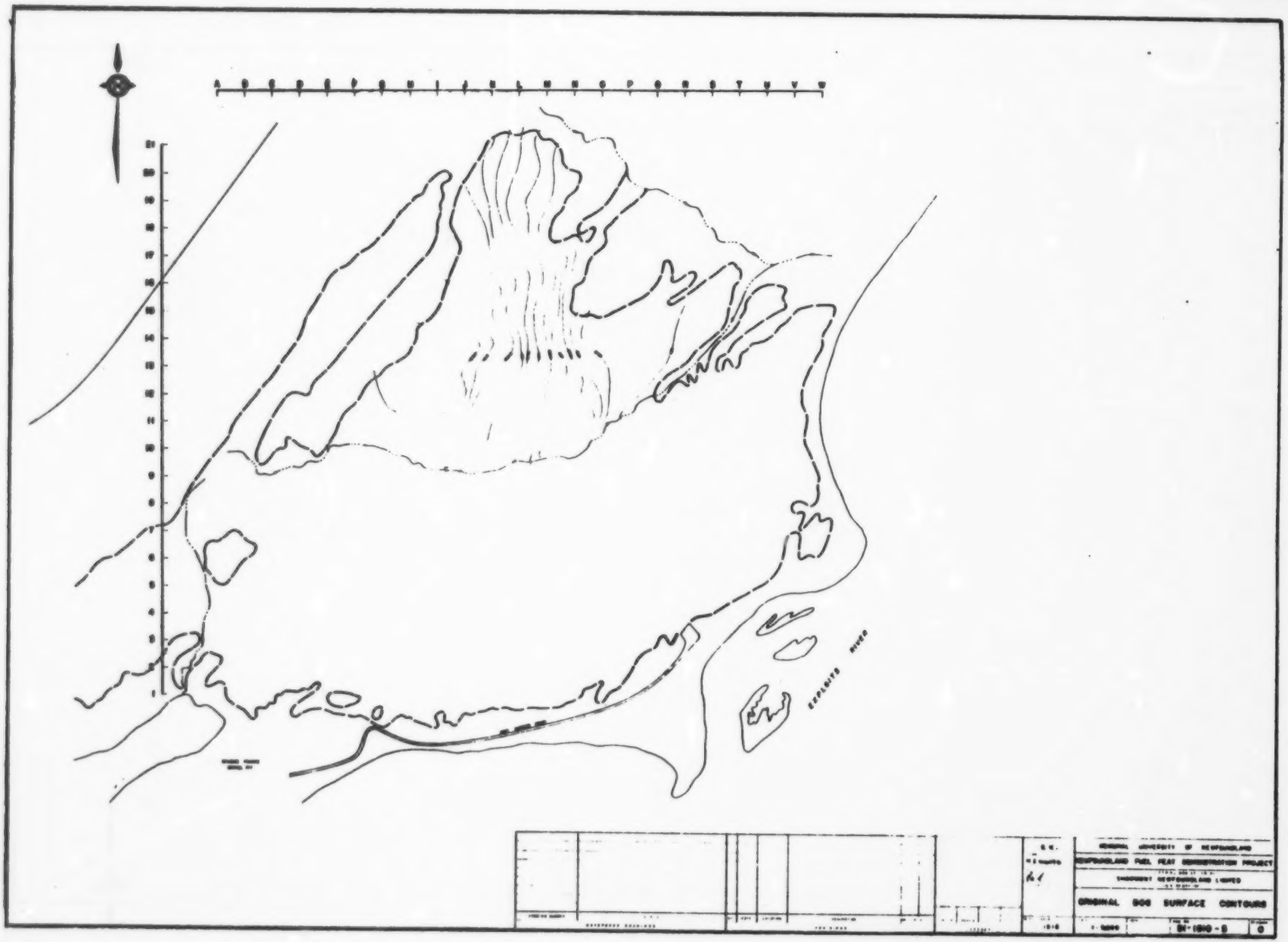
EVALUATION MATRIX FOR BOG SELECTION

# APPENDIX D

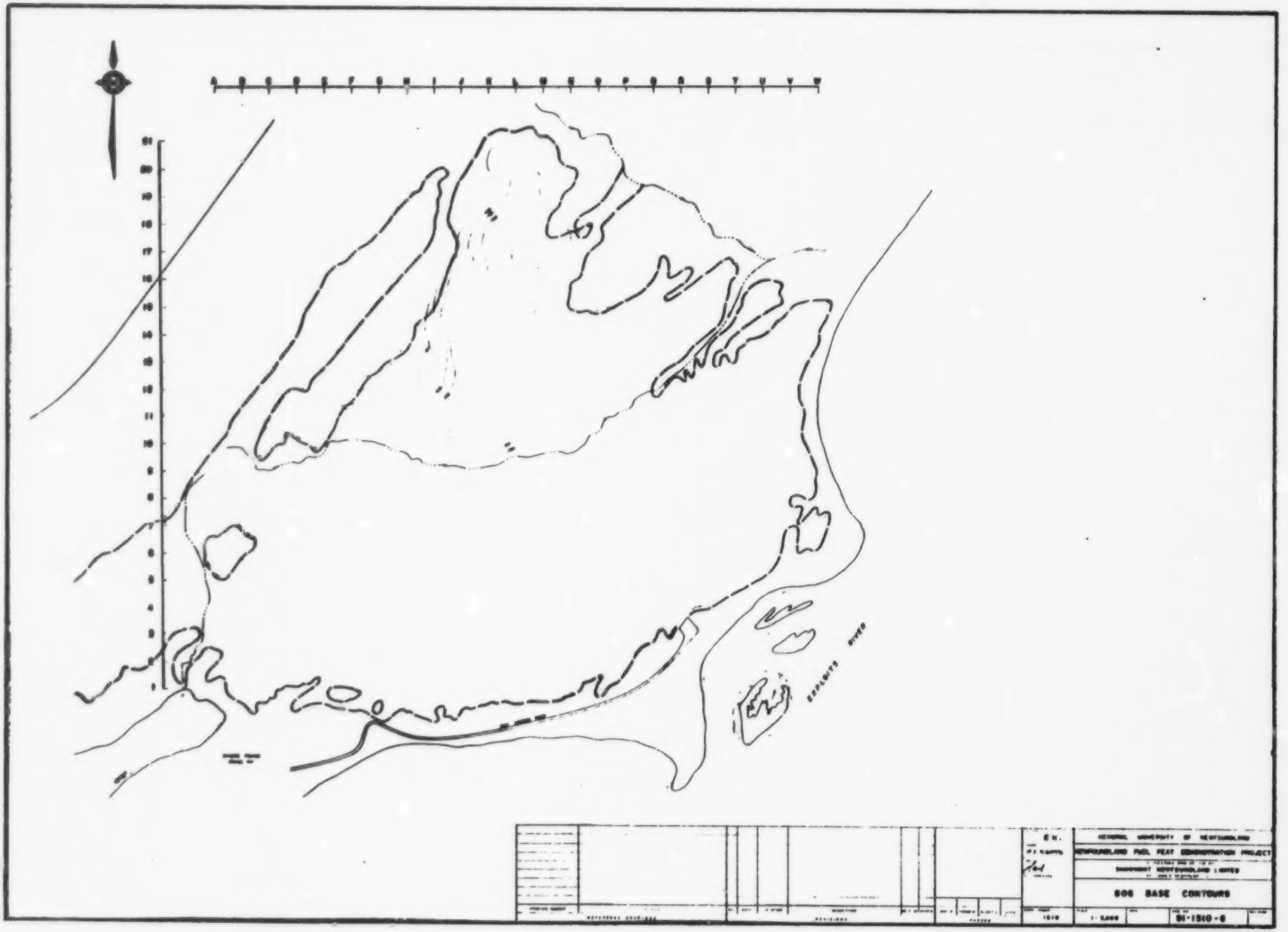
## SURVEY MAPS OF HIGH POINT BOG



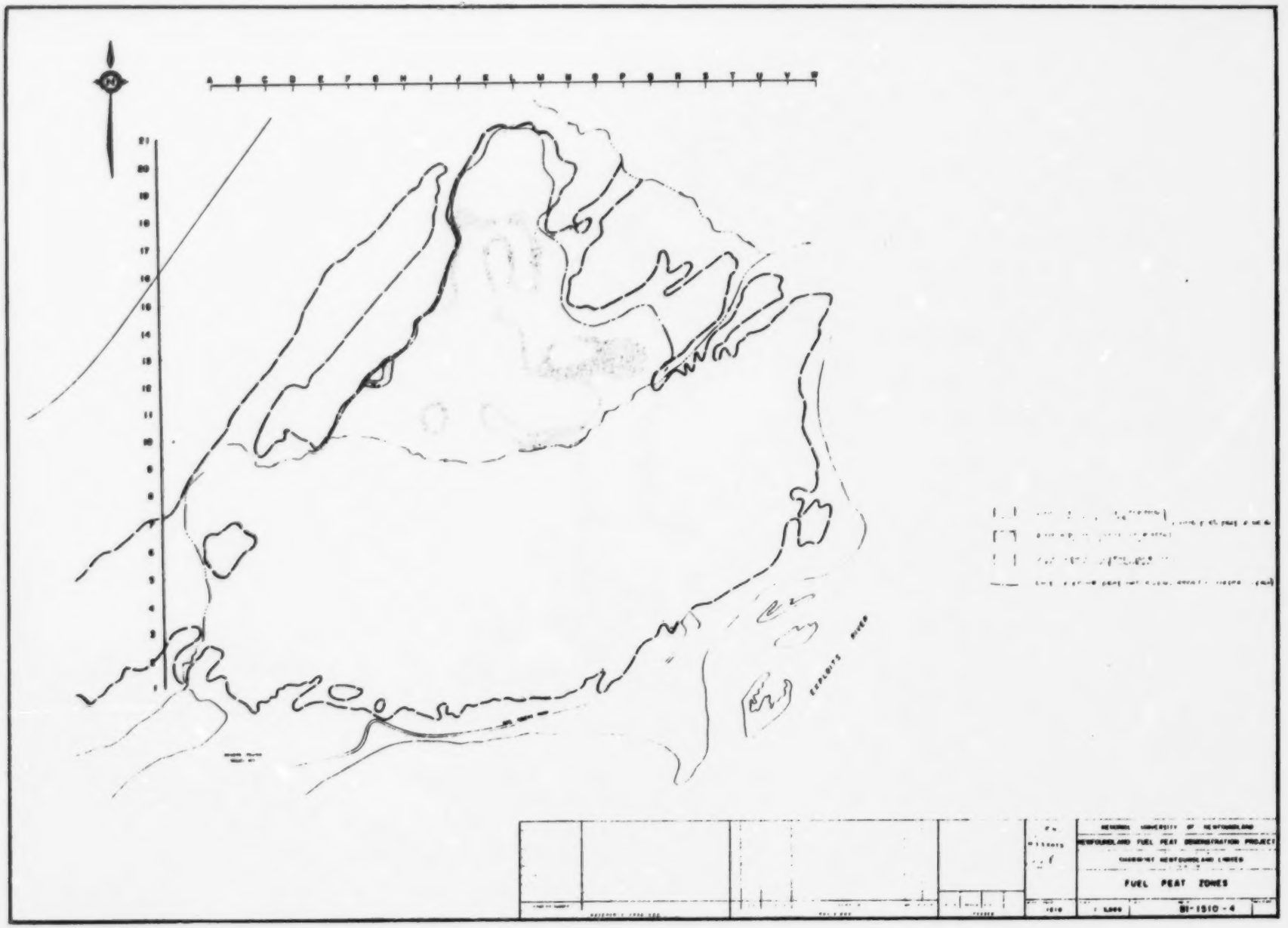

ISOPACHS OF PEAT THICKNESS




ORIGINAL BOG SURFACE CONTOURS




BOG BASE CONTOURS




FUEL PEAT ZONES

# APPENDIX E

## LABORATORY ANALYSIS RESULTS

| User's Sample Code | W.A.F. Code | Depth (m) | Moisture (%) | Ash (%) | Organic Matter (%) |
|---|---|---|---|---|---|
| K5 H3 | 3286 | 0-3.25 | 94.2 | 0.1 | 5.8 |
| K5 H8 | 3287 | 3.25-3.65 | 82.4 | 9.0 | 8.6 |
| K9 H3-H4 | 3288 | 0-4.90 | 93.8 | 0.1 | 6.2 |
| K9 H7 | 3289 | 4.90-5.50 | 94.2 | 0.1 | 5.7 |
| K13 H8 | 3290 | 0.0-2.0 | 90.4 | 0.9 | 8.7 |
| L4 H4 | 3291 | 1.8-2.0 | 92.4 | 0.3 | 7.3 |
| L4 H5 | 3292 | 2.3-2.4 | 94.6 | 0.1 | 5.3 |
| L7 H4 | 3293 | 2.5-5.5 | 94.9 | 0.1 | 5.1 |
| L8 H6 | 3294 | 4.6-5.3 | 90.0 | 0.2 | 9.8 |
| L12 H5 | 3295 | 0.2-1.7 | 90.9 | 0.9 | 8.2 |
| L12 H6-H7 | 3296 | 1.7-2.0 | 92.6 | 0.9 | 6.5 |
| L12 H8 | 3297 | 2.0-2.3 | 88.2 | 2.4 | 9.4 |
| M4 H3 | 3298 | 1.0-2.0 | 95.7 | 0.1 | 4.3 |
| M4 H9 | 3299 | 3.0-3.78 | 92.0 | 0.5 | 7.5 |
| M8 H4(0.00-1.00) | 3300 | 0.0-1.0 | 94.1 | 0.1 | 5.9 |
| M8 H4(3.00-4.00) | 3301 | 3.0-4.0 | 93.6 | 0.1 | 6.4 |
| M8 H6 | 3302 | 4.45-4.90 | 93.3 | 0.2 | 6.5 |
| N1 H3 | 3303 | 0.0-1.30 | 95.1 | 0.1 | 4.9 |
| N1 H4 | 3304 | 1.5-2.0 | 93.6 | 0.1 | 6.4 |
| N4 H4 | 3305 | 0.0-1.0 | 94.2 | 0.1 | 5.8 |
| N4 H5 | 3306 | 1.8-2.0 | 93.9 | 0.1 | 6.1 |
| N4 H6 | 3307 | 4.1-5.0 | 89.1 | 0.5 | 10.4 |
| N4 H7 | 3308 | 5.15-5.5 | 90.1 | 0.7 | 9.2 |
| O1 H3 | 3309 | 0.0-4.2 | 93.1 | 0.2 | 6.7 |
| O1 H8 | 3310 | 4.2-6.0 | 90.2 | 0.8 | 9.0 |
| P1 H6 | 3311 | 3.0-3.3 | 90.2 | 0.3 | 9.5 |
| Q1 H8 | 3312 | 0.35-1.80 | 91.9 | 0.7 | 7.4 |

NOTE: Analyses were performed on the samples in the state they were received in. (i.e., many were very wet).

W.A.F. = Water Analysis Facility

## ANALYTICAL RESULTS - PROXIMATE ANALYSIS

| User's Sample Code | W.A.F. Code | Cost | Value | Units | Source | Comments |
|---|---|---|---|---|---|---|
| K5 H3 | 3286 | | 4600 | cal./g. | | |
| K5 H8 | 3287 | | 3790 | dry wt. | | |
| K9 H3-144 | 3288 | | 4570 | | | BTU/lb = 1.8 cal/g |
| K9 H7 | 3289 | | 5130 | | | heat of vapourization |
| K13 H8 | 3290 | | 5060 | | | of $H_2O$ = 539.55 |
| L4 H4 | 3291 | | 4770 | | | cal/g |
| L4 H5 | 3292 | | 4700 | | | |
| L7 H4 | 3293 | | 4580 | | | Samples were all |
| L8 H6 | 3294 | | 5110 | | | dried before bomb |
| L12 H5 | 3295 | | 4760 | | | calorimetric |
| L12 H6-H7 | 3296 | | 4340 | | | measurements |
| L12 H8 | 3297 | | 4080 | | | due to the |
| M4 H3 | 3298 | | 4630 | | | difficulty of |
| M4 H9 | 3299 | | 4520 | | | pelletizing wet |
| M8 H4 | 3300 | | 4630 | | | samples. |
| M8 H4 | 3301 | | 4580 | | | |
| M8 H6 | 3302 | | 5080 | | | |
| N1 H3 | 3303 | | 4340 | | | |
| N1 H4 | 3304 | | 4650 | | | |
| N4 H4 | 3305 | | 4690 | | | |
| N4 H5 | 3306 | | 4540 | | | |
| N4 H6 | 3307 | | 4940 | | | |
| N4 H7 | 3308 | | 4860 | | | |
| O1 H3 | 3309 | | 4580 | | | |
| O1 H8 | 3310 | | 4730 | | | |
| P1 H6 | 3311 | | 4370 | | | |
| Q1 H8 | 3312 | | 4200 | | | |

## ANALYTICAL RESULTS - CALORIFIC ANALYSIS

# APPENDIX F

# DATA ANALYSIS

**Data Collection**

During the 1981 and 192 production seasons, data were recorded at the site. The activity, time, and related production for each worker were recorded on "activity sheets". These data were then entered in to the computer system at Memorial University, and a statistical package ( MINITAB release 81.1 ) used to obtain the desired information.

**Data Analysis - General**

Interpretation of errors was done on an individual case basis, and dubious data were removed when appropriate. There were insufficient data for a detailed time and motion study.

**Data Analysis - Production Rates**

The basic data set was obtained from fields 42 to 49 during the 1982 season. These fields were in full production for that whole period. Daily service for the tractors and other minor maintenance activities were included inthe production activity times.

The concept of steady state production was used. Short periods of a particular activity were removed, in order to obtain a better representation of the rates that ought to be achieved in a large-scale operation.

Results were obtained as equations of the form $y = ax + b$, where x = the number of hours, a = the rate, and b = an adjustment for maintenance time and other stoppages. Y represents the amount of production achieved, in appropriate units. For the steady state rate, b is generally ignored, since it ought to be insignificant in a large scale operation. Graphs of the actual data are presented at the end of this Appendix.

**Ditching**

MF 275/2 (modified) with Dondi Ditching Attachment
Range 100 m/hr to 433 m/hr
Average 261 m/hr

Kubota Backhoe
$y = 8.76x - 4.85$ overall
$y = 8.1x$ steady state ( periods over 5 hrs )

**Milling**

MF 275/2 with screw miller
$y = 1.61x + 0.398$

MF 285/4 with screw miller
$y = 1.58x + 0.385$

V160 with screw miller
$y = 2.15x - 1.73$

Steady state figures could not be isolated from the milling data. The rates achieved were highly variable, especially at the higher activity times. It was suspected that some times were recorded on re-milling a field after a heavy rainfall, which may account for some of the variation.

**Harrowing**

MF 255/2

$y = 9.9x + 1.38$ overall
$y = 9.8x$ steady state

MF 275/2

$y = 11.4x - 1.52$

MF 255/4

10.9 ha/hr (average of three trials)

**Ridge Ploughing**

MF 255/4

$y = 2.46x - 0.108$ overall
$y = 2.46x$ steady state

Kubota

Range 1.9 to 2.4 ha/hr (3 trials)

**Ridge Loading**

The ridge loader was used in conjuntion with both one and two wagons. The rates were converted to wagonloads per hour per tractor in use (i.e. two tractors with one wagon, three with two wagons). The resultant rate must be multiplied by two or three to obtain the actual rate of harvesting.

MF 275/2

$y = 2.46x - 1.9$ overall

MF 285/4

$y = 2.3x + 1.71$ overall
$y = 2.4x$ steady state

For the wagons used for ridge loading (and bucket loading and peat moving),
1 wagonload = 16.3 $m^3$ at .14 $t/m^3$
= 2.3 t

**Bucket Loading**

Average rate 2.56 wagonloads per hour per machine
(see comments on ridge loading)

**Peat Moving**

MF 285/4

$y = 1.8x - 2.2$ wagonloads per hour per machine
(see comments on ridge loading)

**Vacuum Loading**

Only a small number of observations were made of the vacuum harvester. Consequently, no statistical analysis could be done. The results achieved were:

MF 255/2

2.5 to 3.5 loads per hour

MF 275/2

2.6 to 3.6 loads per hour

Combined average rate: 3.14 loads per hour

For the vacuum harvester 1 load = 12.3 $m^3$ at .14 $t/m^3$
= 1.75 t

**Calculation of Area for Full Utilization**

During the 1982 season, five tractors worked 21 ha, at 17% utilization. At 100% utilization, these machines shoud have been able to work 124.2 ha. Adjusting this figure for repair time, using the proportion found during the season, gave a figure of 94.7 ha. It was considered however, that the repair time in the project was inflated by lack of decent repair facilities and a very small inventory of spares.

Using all available machine time for five tractors, it would be possible to mill such an area 20.4 times and harrow it 71.5 times. This would result in peat harvesting at a moisture content equal to that achieved on fields 42 to 49 during the project, where the average number of millings was 27.4 and of harrowings, 96.9. Converting the 94.7 ha, the smallest field area which would be necessary for a five-tractor operation would be just over 70 ha.

**Derivation of Production Costs**

The general equation used was:

Operation cost = Machine time x (fuel cost/hr + maintenance weight/hr)
+ Labour time x Labour rate

Fuel costs per hour were $3 for the MF 285/4, and $2.40 for all others. Labour raate for operators was $7.80, and the maintenance weight was $7.72 per hour of machine time.

Field 45 was selected as representative of the operation. Data from this field were used to derive costs. The area of Field 45 was 22.736 ha. The data are presented in the following table.

| Factor | Operation | | | |
|---|---|---|---|---|
| | Milling | Harrowing | Ridging | Ridge Loading |
| Number of times | 28 | 99 | 25 | not applicable |
| Area covered ha | 22.7 | 80.3 | 20.3 | not applicable |
| No. of loads | n/a | n/a | n/a | 72 |
| Hourly rate | 1.75 ha | 9.78 ha | 2.46 ha | 7.17 loads |
| Machine hours | 13 | 8.2 | 8.3 | 10 |
| Operator hours | 16 | 9.4 | 9.7 | 12.7 |
| Total cost $ | 256.34 | 156.66 | 158.84 | 608.90 |

The total cost of production on field 45 was calculated to have been $1180.74. This produced 72 wagonloads of 16.3 $m^3$ each, at a bulk density of 0.14 $t/m^3$, for a total of 166.5 tonnes, thus giving a cost of $7.09 per tonne.

The total production results were also analyzed. These produced the data shown below. The total production waas 1164.5 tonnes for a cost of $8468.20. This translates to a production cost of $7.27 per tonne.

All the harvesting on fields 42 to 49 was done by ridge loading. Costs for vacuum harvesting had to be derived by comparison of production rates. It was assumed that the milling and harrowing costs would be the same. Since the moisture content of the harvested peat was the same, this appeared to be reasonable.

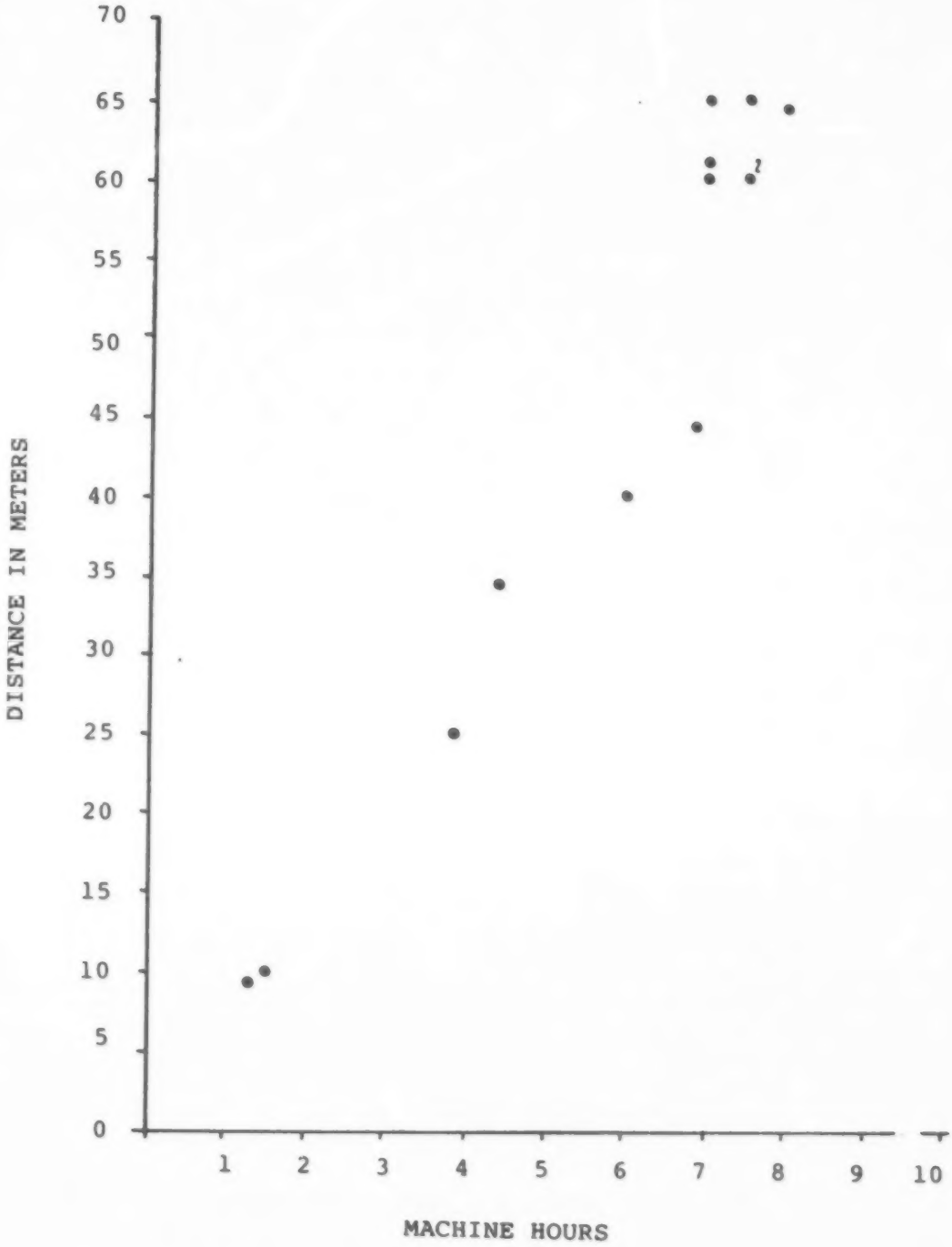
The 1164.5 tonnes harvested would have been 667.3 loads for the vacuum harvester, the capacity of which was 12.3 $m^3$. This would have consumed 212.3 hors of machine time, and 246.7 operator hours. Accordingly, vacuum harvesting would have cost $4073.16. Adding the milling and harrowing costs (but not the ridging), the total production cost for vacuum harvesting was estimated as $7078.78, or $6.08 per tonne.

| PRODUCTION ITEM | | FIELD 42 | FIELD 43 | FIELD 44 | FIELD 45 | FIELD 46 | FIELD 47 | FIELD 48 | FIELD 49 | TOTAL | AVERAGE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MILLING | Number of Times | 27 | 26 | 27 | 28 | 29 | 27 | 25 | 30 | 219 | 27 |
| | Length of Field | 360 | 361 | 418 | 406 | 397 | 387 | 367 | 327 | 3023 | 378 |
| | Area Covered (ha) | 20 | 19 | 23 | 23 | 23 | 21 | 18 | 20 | 165 | 21 |
| | Machine Hours | 11 | 11 | 13 | 13 | 13 | 12 | 11 | 11 | 96 | 12 |
| | Operator Hours | 14 | 13 | 16 | 16 | 16 | 15 | 13 | 14 | 117 | 15 |
| | Milling Cost | $219.19 | $211.65 | $254.49 | $256.34 | $259.61 | $235.62 | $206.90 | $221.20 | $1,865.00 | $233.13 |
| HARROWING | Number of Times | 90 | 89 | 87 | 99 | 104 | 101 | 98 | 107 | 775 | 97 |
| | Length of Field | 360 | 361 | 418 | 406 | 397 | 387 | 367 | 327 | 3023 | 378 |
| | Area Covered (ha) | 65 | 65 | 73 | 80 | 83 | 78 | 72 | 70 | 585 | 73 |
| | Machine Hours | 7 | 7 | 7 | 8 | 9 | 8 | 7 | 7 | 60 | 8 |
| | Operators Hours | 8 | 8 | 9 | 9 | 10 | 9 | 8 | 8 | 67 | 9 |
| | Harrowing Costs | $126.36 | $125.28 | $141.82 | $156.66 | $161.01 | $152.43 | $140.26 | $136.45 | $1,140.27 | $142.53 |
| RIDGING | Number of Times | 25 | 23 | 24 | 25 | 28 | 26 | 25 | 28 | 204 | 26 |
| | Length of Field | 360 | 361 | 406 | 406 | 397 | 387 | 367 | 327 | 3023 | 378 |
| | Area Covered | 18 | 17 | 20 | 20 | 22 | 20 | 18 | 18 | 154 | 19 |
| | Machine Hours | 7 | 7 | 8 | 8 | 9 | 8 | 8 | 8 | 63 | 8 |
| | Operators Hours | 9 | 8 | 10 | 10 | 11 | 10 | 9 | 9 | 76 | 9 |
| | Ridging Cost | $140.84 | $129.93 | $156.99 | $158.84 | $173.95 | $157.46 | $143.58 | $143.28 | $1,204.87 | $150.61 |
| RIDGE LOADING | Number of Loads | 58 | 46 | 42 | 72 | 88 | 71 | 58 | 69 | 504 | 63 |
| | Machine Hours | 8 | 6 | 6 | 10 | 12 | 10 | 8 | 10 | 70 | 9 |
| | Operator Hours | 10 | 8 | 7 | 13 | 16 | 13 | 10 | 12 | 89 | 11 |
| | Ridge Loading Cost | $490.50 | $389.02 | $350.96 | $608.90 | $744.21 | $600.44 | $490.50 | $583.53 | $4,258.06 | $532.26 |
| TOTAL COST ($) | | $976.89 | $855.88 | $904.26 | $1,180.74 | $1,338.78 | $1,145.95 | $981.24 | $1,084.46 | $8,468.20 | $1,058.53 |

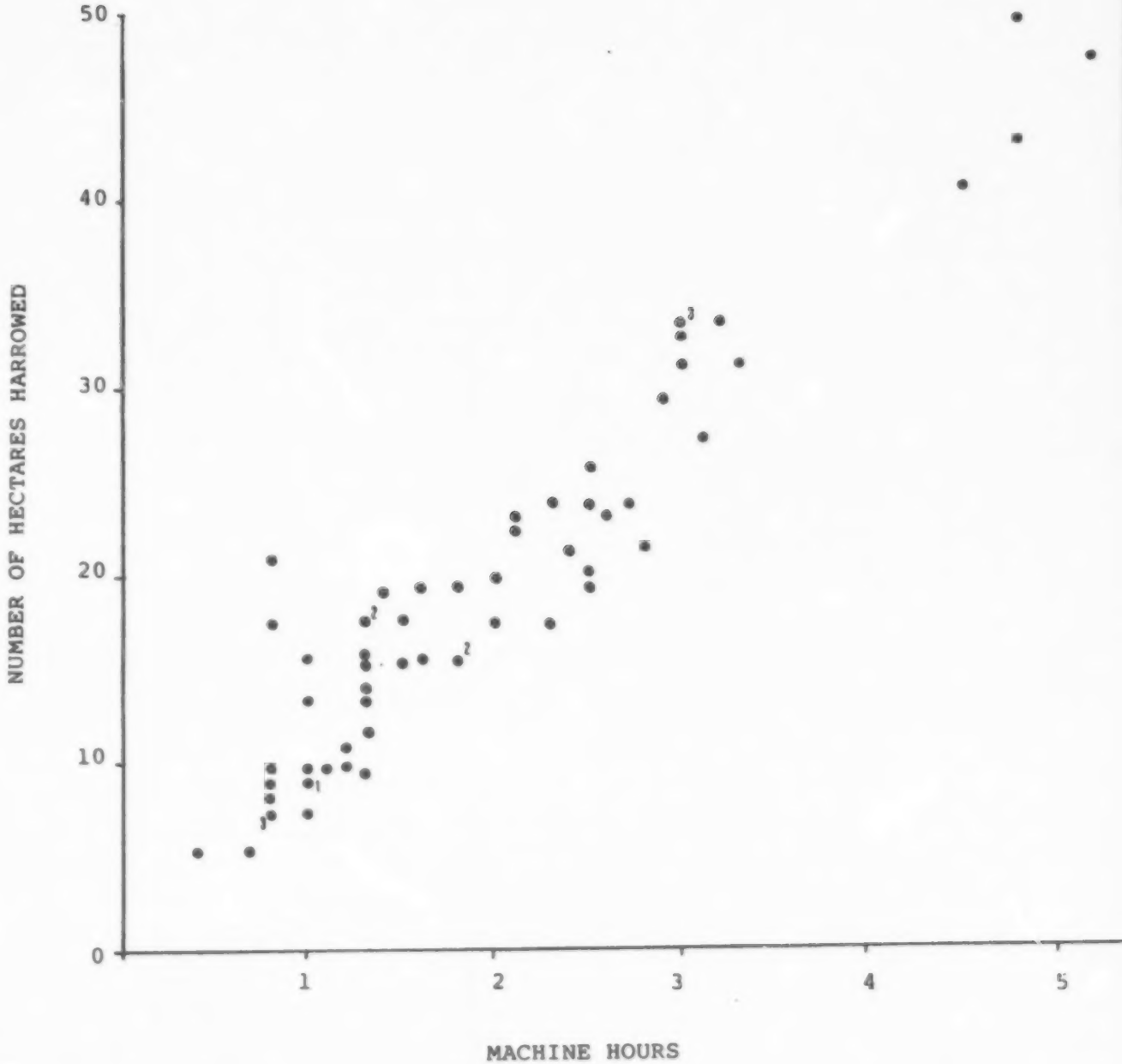
NOTES:

1. Milling Data (M) - Rate Used = 1.75 ha/yr, Operator Hours = 1.2321429 x Machine Hours
2. Harrowing Data (H) - Rate Used = 9.78 ha/hr, Operator Hours = 1.474259 x Machine Hours
3. Ridging Data (R) - Rate Used = 2.46 ha/hr, Operator Hours = 1.1702742 x Machine Hours
4. Ridge Loading Data (R.L.) - Rate Used = 7.171 Load/hr, Operator Hours = 1.268226 x Machine Hours
5. Numbers Reported are Rounded
6. Totals and Averages are Calculated

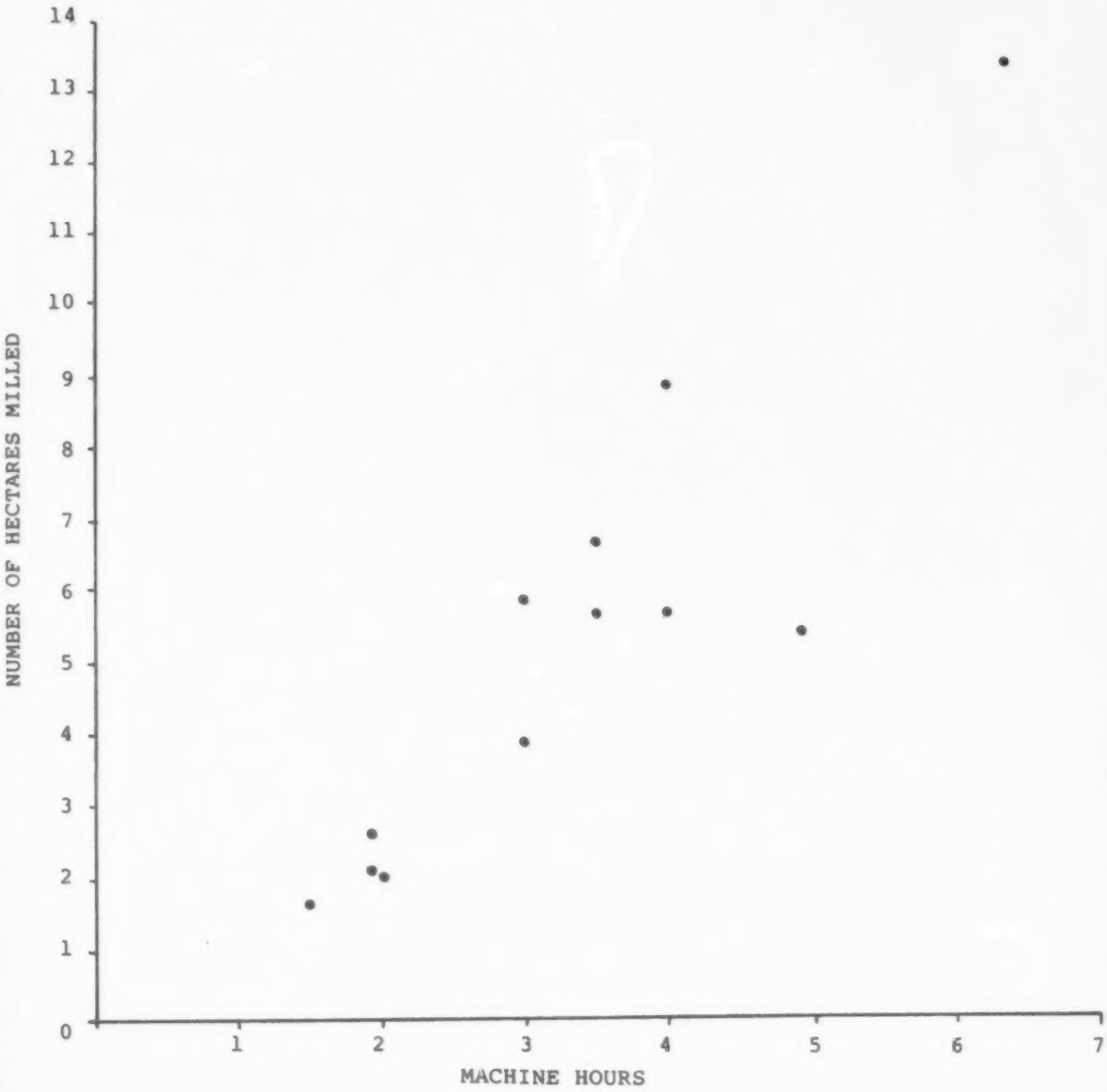
SUMMARY OF COST COMPARISONS FOR FIELDS 42 TO 49



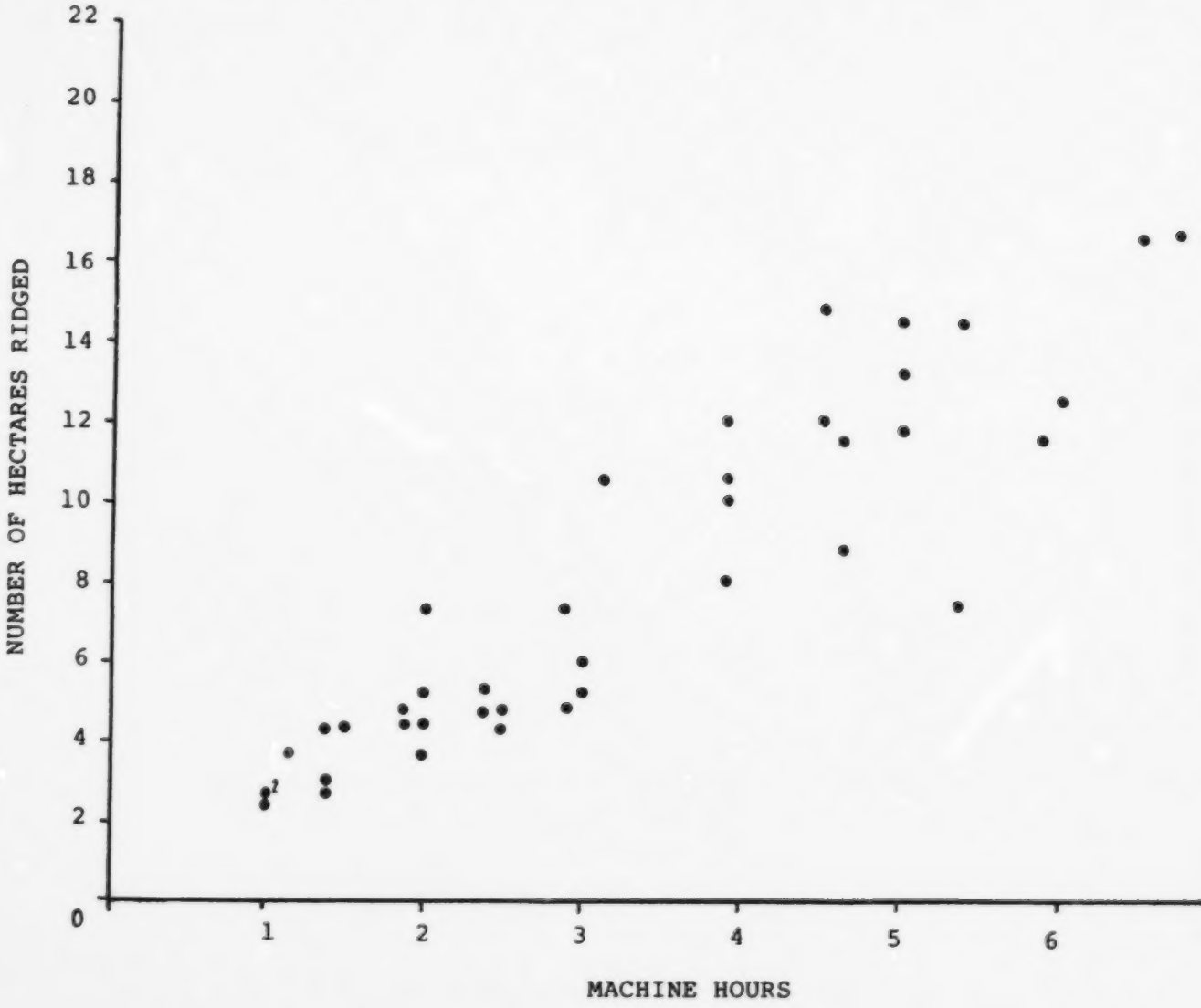

DITCHING GRAPH - METERS DITCHED PER HOUR



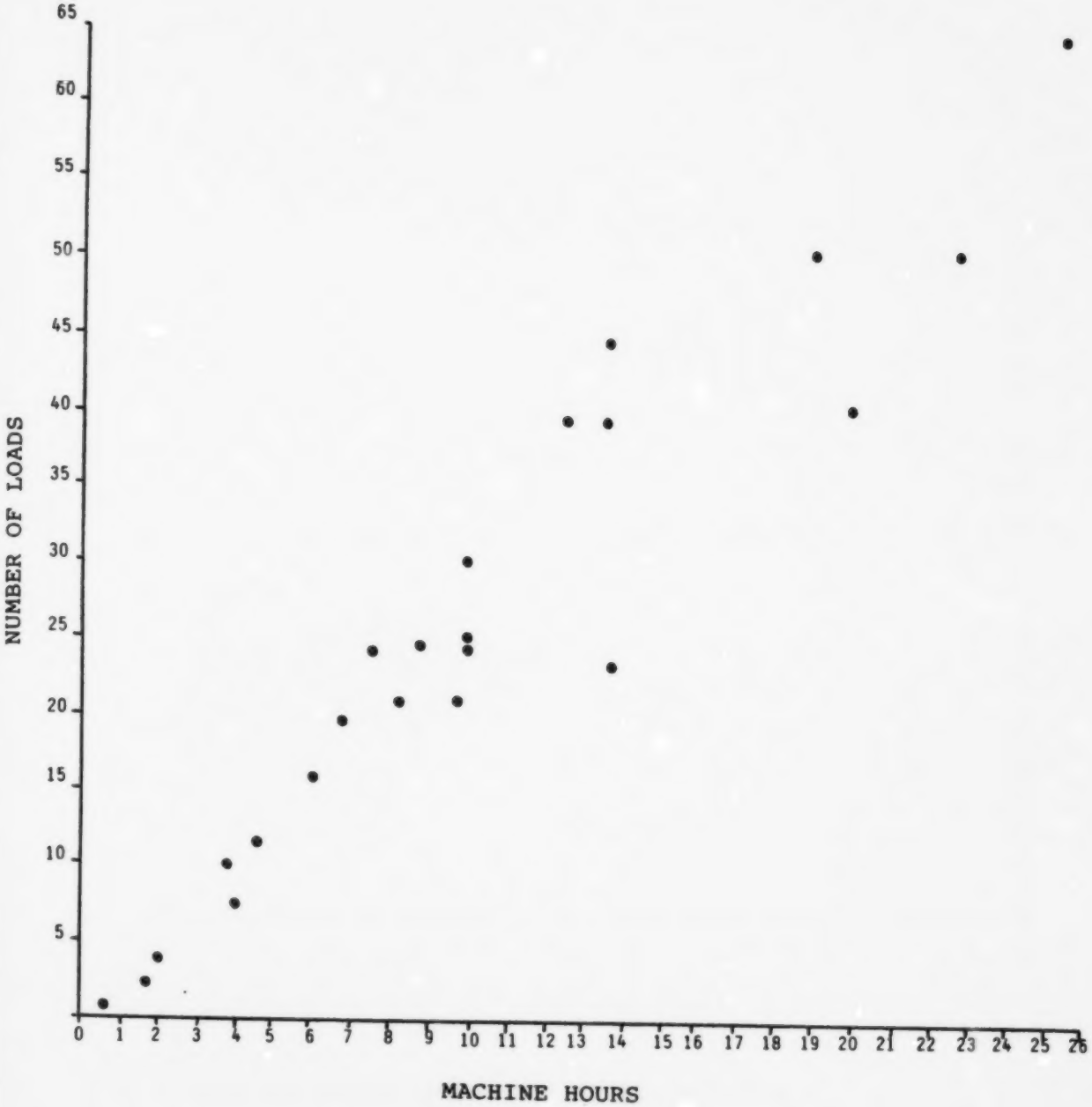

HARROWING GRAPH - HECTARES PER HOUR



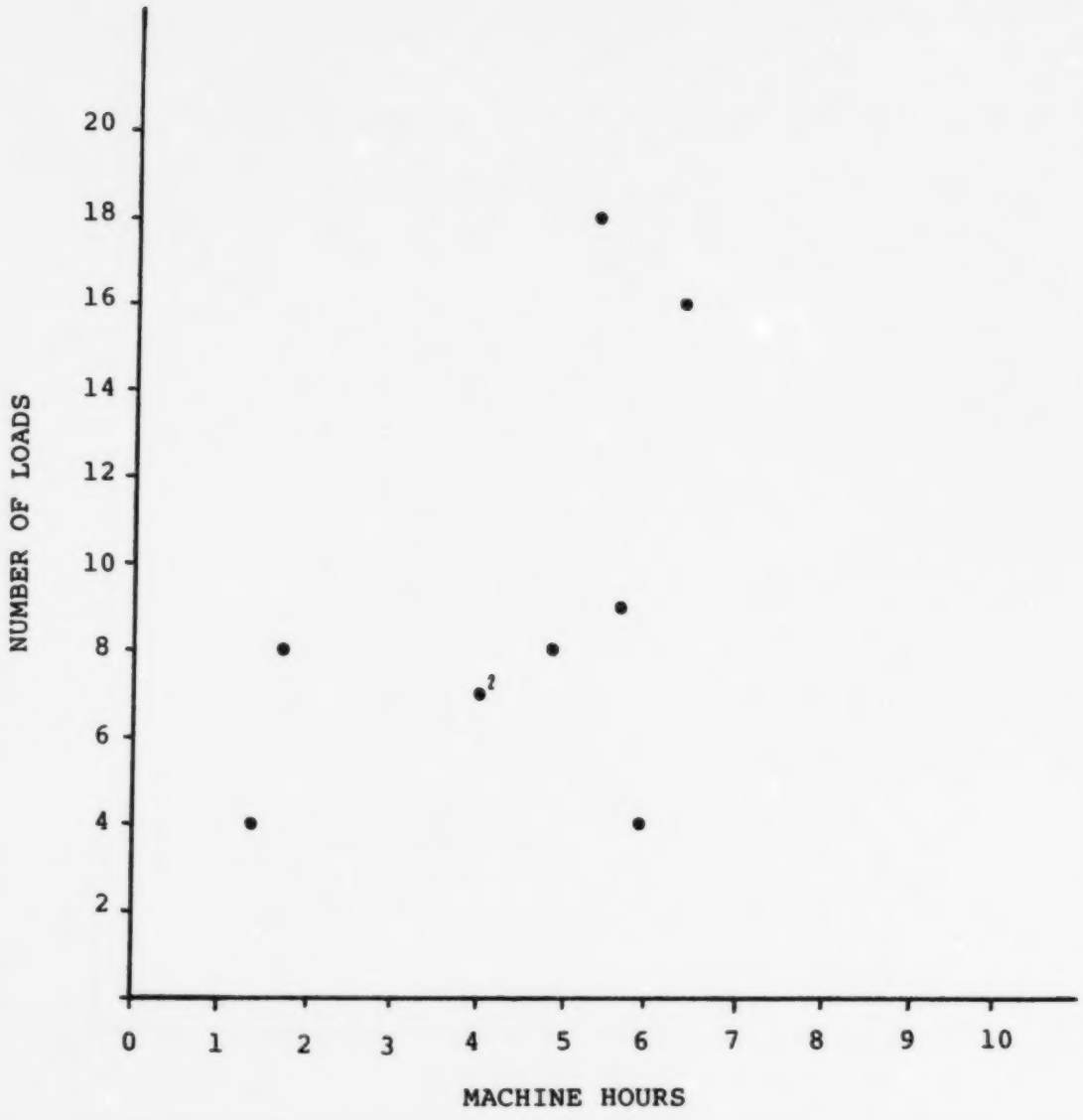

MILLING GRAPH - HECTARES PER HOUR (USING V160 TRACTOR)




RIDGING GRAPH - RIDGED HECTARES PER HOUR (USING MF255)




RIDGE LOADING GRAPH - LOADS PER HOUR (USING MF285)




RIDGEPLO GRAPH - RIDGEPLO LOADS PER HOUR

# APPENDIX G

## ENVIRONMENTAL MONITORING GRAPHS, 1980

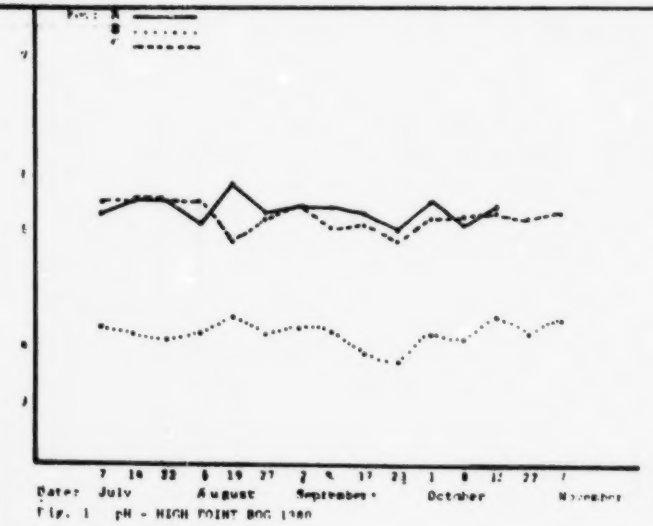


Fig. 1 pH - HIGH POINT BOG 1980

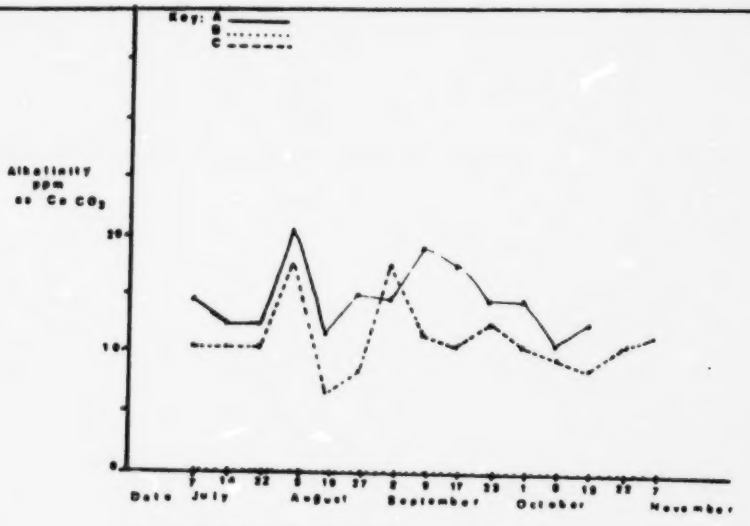


FIG 2 ALKALINITY-HIGH POINT BOG 1980

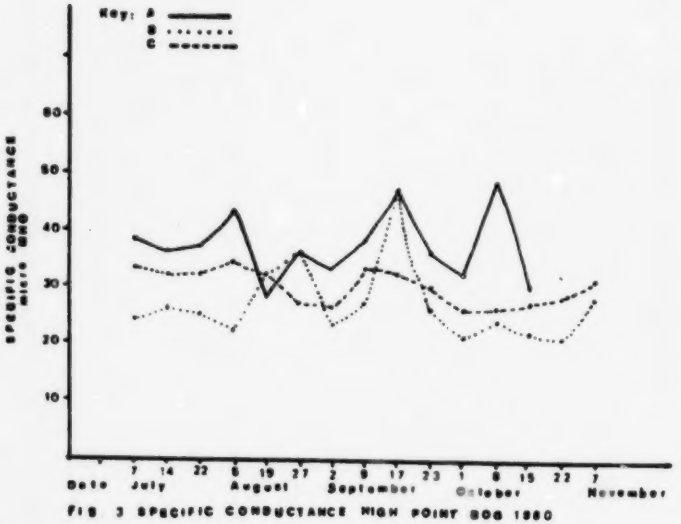


FIG 3 SPECIFIC CONDUCTANCE HIGH POINT BOG 1980

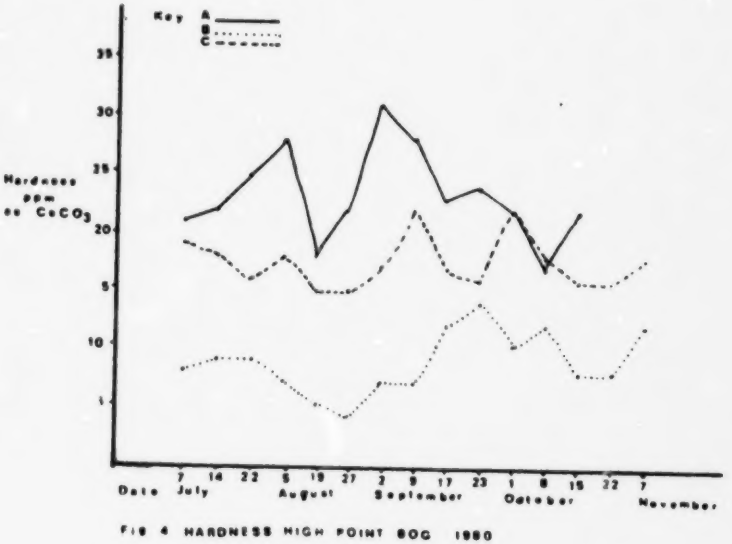


FIG 4 HARDNESS HIGH POINT BOG 1980

ENVIRONMENTAL PARAMETERS: pH, ALKALINITY, SPECIFIC CONDUCTANCE AND, HARDNESS

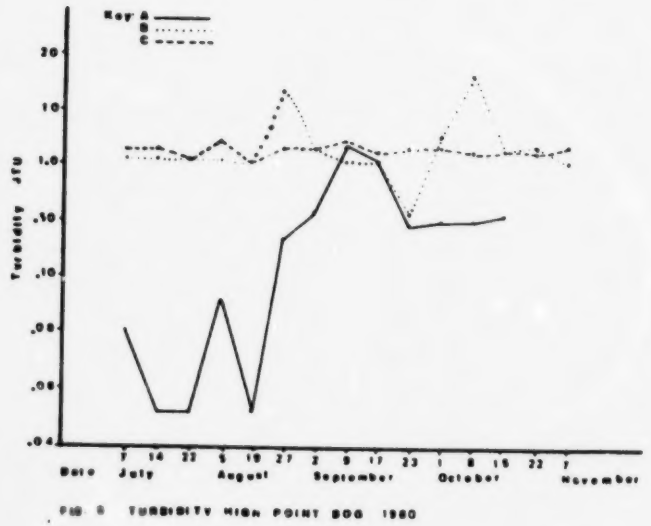



FIG 8 TURBIDITY HIGH POINT BOG 1980

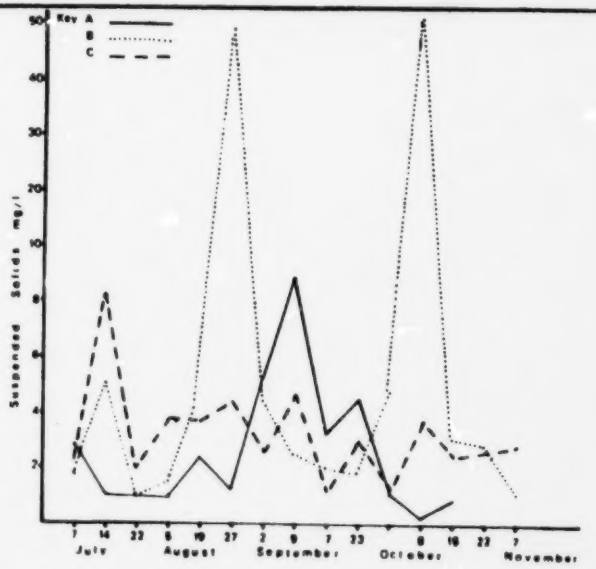



Fig 8 Suspended Solids High Point Bog 1980

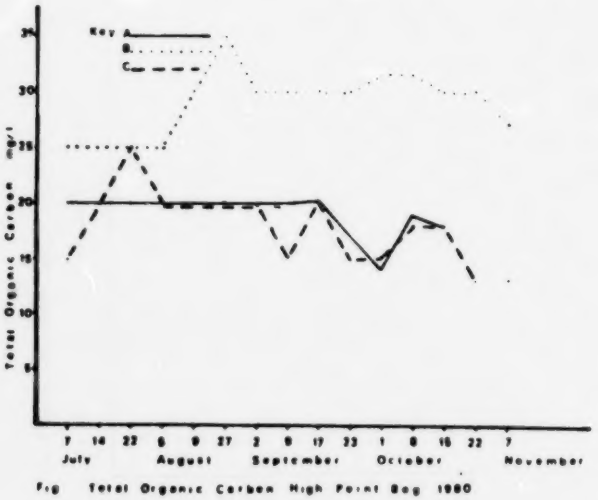



Fig Total Organic Carbon High Point Bog 1980

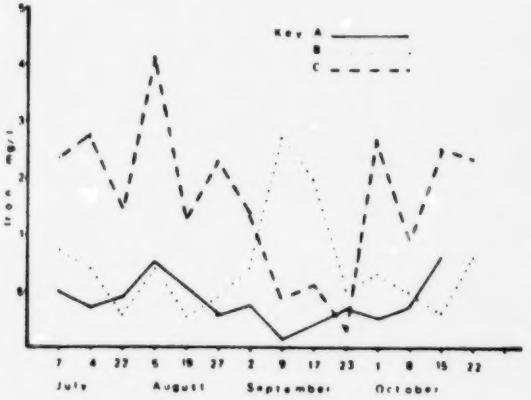
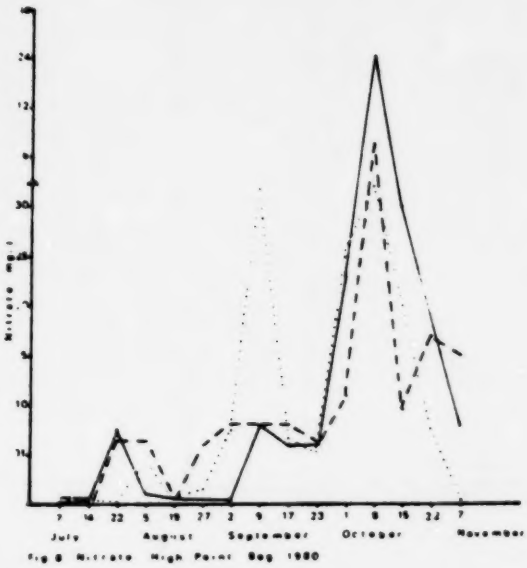



Fig 8 Iron High Point Bog 1980

ENVIRONMENTAL PARAMETERS: TURBIDITY, SUSPENDED SOLIDS,
TOTAL ORGANIC CARBON AND IRON



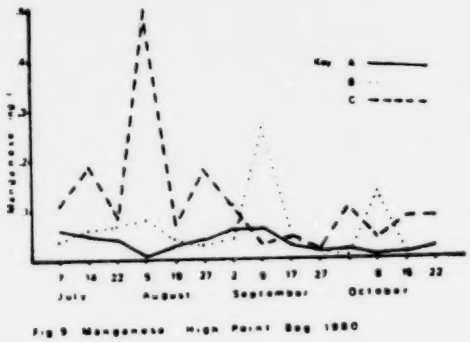




Fig 9 Manganese High Point Bog 1980

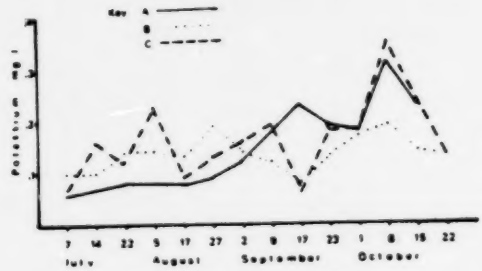



Fig 10 Potassium High Point Bog 1980

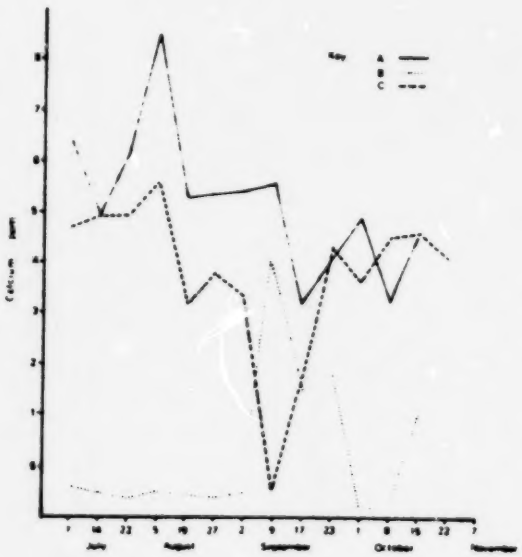



Fig 11 Calcium High Point Bog 1980

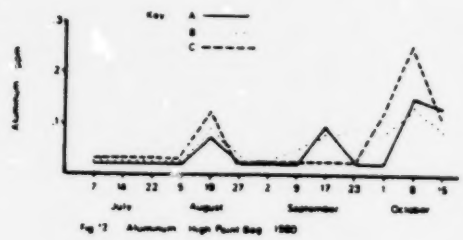



Fig 12 Aluminum High Point Bog 1980

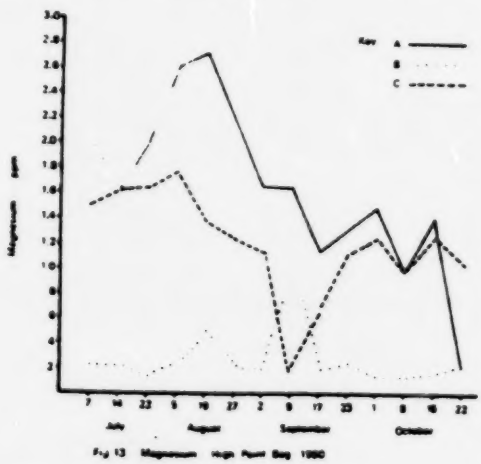



Fig 13 Magnesium High Point Bog 1980

ENVIRONMENTAL PARAMETERS: MANGANESE, NITRATE, POTASSIUM, CALCIUM, ALUMINUM AND MAGNESIUM

# APPENDIX H

# MODEL CASH FLOW ANALYSIS

D C F ON FUEL PEAT PROJECT

| PLANT AND EQUIPMENT COSTS | YEAR 1 | YEAR 2 | YEAR 3 | YEAR 4 | YEAR 5 | YEAR 6 | YEAR 7 | YEAR 8 | YEAR 9 |
|---|---|---|---|---|---|---|---|---|---|
| CLASS 10 ASSETS | - | - | - | - | - | - | - | - | - |
| MF275-A | - | 19,717 | - | - | - | - | - | - | - |
| MF275-B | - | 19,717 | - | - | - | - | - | - | - |
| MF565 | - | 41,248 | - | - | - | - | - | - | 17,745 |
| MF255-A | - | 44,298 | - | - | - | - | - | 35,854 | - |
| MF255-B | - | 44,298 | - | - | - | - | 35,432 | - | - |
| LOADER | - | 32,936 | - | - | - | 33,218 | - | - | - |
| WAGONS | - | 12,238 | - | - | - | 24,477 | - | - | 12,238 |
| CLASS 8 ASSETS: | | | | | | | | | |
| SCHEW LEVELERS | - | 36,688 | - | - | - | - | - | - | 36,688 |
| RIDGE PLOUGH | - | 18,898 | - | - | - | - | - | - | 18,898 |
| DITCHER | - | 35,108 | - | - | - | - | - | - | 35,108 |
| SPOON HARROWS | - | 8,978 | - | - | - | - | - | - | 8,978 |
| MILLER | - | 34,888 | - | - | - | - | - | - | 34,888 |
| CLASS 6 ASSETS: | | | | | | | | | |
| BOG DEVELOPMENT COSTS | 300,888 | - | - | - | - | - | - | - | - |
| OFFICE AND GARAGE | 80,888 | - | - | - | - | - | - | - | - |
| CLASS 17 ASSETS: | | | | | | | | | |
| ROADS TO SITE | 78,888 | - | - | - | - | - | - | - | - |
| TOTAL CAPITAL OUTLAY FOR YEAR | 458,888 | 339,688 | - | - | - | 57,695 | 35,432 | 35,854 | 155,535 |

Plant and Equipment Costs - Year 1 to 9

| VARIABLE & QUASI-VARIABLE COST (EXCEPTING CCA): | YEAR 1 | YEAR 2 | YEAR 3 | YEAR 4 | YEAR 5 | YEAR 6 | YEAR 7 | YEAR 8 | YEAR 9 |
|---|---|---|---|---|---|---|---|---|---|
| INSURANCE | 2,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 |
| LAND RENT @$15/HA | 1,500 | 1,500 | 1,500 | 1,500 | 1,500 | 1,500 | 1,500 | 1,500 | 1,500 |
| ELECTRICITY | 1,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 |
| PROPERTY TAXES | - | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 |
| PICK-UP RENTAL | 1,000 | 6,000 | 6,000 | 6,000 | 6,000 | 6,000 | 6,000 | 6,000 | 6,000 |
| MANAGER | 6,000 | 30,000 | 30,000 | 30,000 | 30,000 | 30,000 | 30,000 | 30,000 | 30,000 |
| FOREMAN | 30,000 | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 |
| BOOKKEEPER | - | 15,000 | 15,000 | 15,000 | 15,000 | 15,000 | 15,000 | 15,000 | 15,000 |
| SITE MAINTENANCE | 15,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 |
| ROYALTY @$15/M3 | - | 823 | 823 | 823 | 823 | 823 | 823 | 823 | 823 |
| WORKING CAPITAL COST @ 1% OF GROSS REV. EXCEPT YR 1? | - | | | | | | | | |
| OTHER DIRECT COSTS OF PROD.& TRANSPORT, LABOUR, FUEL,ETC. @15.03/Tonne | 2,408 | 4,800 | 4,800 | 4,800 | 4,800 | 4,800 | 4,800 | 4,800 | 4,800 |
| VARIABLE & QUASI VAR. COSTS EXCEPTING CCA | - | 288,576 | 288,576 | 288,576 | 288,576 | 288,576 | 288,576 | 288,576 | 288,576 |
| | 60,908 | 383,699 | 383,699 | 383,699 | 383,699 | 383,699 | 383,699 | 383,699 | 383,699 |
| TOTAL PRODUCTION (TONNES) | - | 19,200 | 19,200 | 19,200 | 19,200 | 19,200 | 19,200 | 19,200 | 19,200 |
| TOTAL REVENUE FROM SALES @ $25/TONNE | - | 480,000 | 480,000 | 480,000 | 480,000 | 480,000 | 480,000 | 480,000 | 480,000 |
| CCA RATES ON ASSETS BY CLASS | | | | | | | | | |
| CCA RATE ON CLASS 6 ASSETS IS 10% PER YEAR | - | - | - | - | - | - | - | - | - |
| CCA RATE ON CLASS 17 ASSETS IS 8% PER YEAR | - | - | - | - | - | - | - | - | - |
| CCA RATE ON CLASS 10 ASSETS IS 30% PER YEAR | - | - | - | - | - | - | - | - | - |
| CCA RATE ON CLASS 8 ASSETS IS 20% PER YEAR | - | - | - | - | - | - | - | - | - |

Variable and Quasi - Variable Costs - Year 1 to 9

| SECTION SHOWING CASH FLOW: | YEAR 1 | YEAR 2 | YEAR 3 | YEAR 4 | YEAR 5 | YEAR 6 | YEAR 7 | YEAR 8 | YEAR 9 |
|---|---|---|---|---|---|---|---|---|---|
| CAPITAL COST ALLOWANCE (CCA) | 21,888 | 86,158 | 114,638 | 98,893 | 71,723 | 59,761 | 66,561 | 64,878 | 67,344 |
| UNDEPRECIATED CAPITAL COST AT END OF YEAR | 428,288 | 671,929 | 559,251 | 478,726 | 488,258 | 399,196 | 368,878 | 348,488 | 418,678 |
| SALE OF ASSETS IN 17TH. YR & UNDEPRECIATED CAP. COST | - | - | - | - | - | - | - | - | - |
| TOTAL VAR.& QUASI VAR.COST | 60,988 | 383,699 | 383,699 | 383,699 | 383,699 | 383,699 | 383,699 | 383,699 | 383,699 |
| NET OPERATING REVENUE (GRS. REV. LESS TVC) | (60,988) | 96,381 | 96,381 | 96,381 | 96,381 | 96,381 | 96,381 | 96,381 | 96,381 |
| TAXABLE INCOME (NET OPR. REV. LESS CCA) | (82,788) | 10,151 | (18,337) | 6,288 | 24,578 | 36,548 | 29,748 | 32,223 | 28,957 |
| TAX PAYABLE @ CORP. RATE OF 46% | (38,842) | 4,669 | (8,435) | 2,856 | 11,386 | 16,888 | 13,688 | 14,823 | 13,328 |
| NET INCOME OR PROFIT (TAXABLE INCOME LESS TAX PAYABLE) | (44,658) | 5,482 | (9,982) | 3,352 | 13,272 | 19,732 | 16,868 | 17,488 | 15,637 |
| NET OPERATING CASH FLOW (NET INCOME PLUS CCA) | (22,858) | 91,632 | 104,736 | 93,445 | 84,995 | 79,493 | 82,621 | 81,478 | 82,981 |
| TOTAL CASH FLOW (NET OPR. CASH FLOW PLUS CAPITAL OUTLAY) | (472,858) | (248,848) | 104,736 | 93,445 | 84,995 | 21,798 | 47,189 | 46,424 | (72,554) |

RETURN ON INVESTMENT = 8.231%

Cash Flow - Year 1 to 9

| PLANT AND EQUIPMENT COSTS | YEAR 10 | YEAR 11 | YEAR 12 | YEAR 13 | YEAR 14 | YEAR 15 | YEAR 16 | YEAR 17 |
|---|---|---|---|---|---|---|---|---|
| CLASS 10 ASSETS | - | - | - | - | - | - | - | - |
| MF275-A | 18,731 | - | - | - | 14,788 | - | - | - |
| MF275-B | - | - | - | 14,788 | - | - | - | - |
| MF285 | - | - | 38,938 | - | - | - | - | - |
| MF255-A | - | 33,218 | - | - | - | - | - | - |
| MF255-B | 33,218 | - | - | - | 33,218 | - | - | - |
| LOADER | 24,477 | - | - | - | 24,477 | - | - | - |
| WAGONS | - | - | - | - | - | - | - | - |
| CLASS 8 ASSETS: | | | | | | | | |
| SCREW LEVELERS | - | - | - | - | - | - | - | - |
| RIDGE PLOUGH | - | - | - | - | - | - | - | - |
| DITCHER | - | - | - | - | - | - | - | - |
| SPOON HARROWS | - | - | - | - | - | - | - | - |
| MILLER | - | - | - | - | - | - | - | - |
| CLASS 6 ASSETS: | | | | | | | | |
| BOG DEVELOPMENT COSTS | - | - | - | - | - | - | - | - |
| OFFICE AND GARAGE | - | - | - | - | - | - | - | - |
| CLASS 17 ASSETS: | | | | | | | | |
| ROADS TO SITE | - | - | - | - | - | - | - | - |
| TOTAL CAPITAL OUTLAY PER YEAR | 76,426 | 33,218 | 38,938 | 14,788 | 72,483 | - | - | - |

Plant and Equipment Costs - Year 10 to 17

| VARIABLE & QUASI-VARIABLE COST (EXCEPTING CCA)! | YEAR 10 | YEAR 11 | YEAR 12 | YEAR 13 | YEAR 14 | YEAR 15 | YEAR 16 | YEAR 17 |
|---|---|---|---|---|---|---|---|---|
| INSURANCE | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 2,000 |
| LAND RENT @$15/HA | 1,500 | 1,500 | 1,500 | 1,500 | 1,500 | 1,500 | 1,500 | 1,500 |
| ELECTRICITY | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| PROPERTY TAXES | 6,000 | 6,000 | 6,000 | 6,000 | 6,000 | 6,000 | 6,000 | 6,000 |
| PICK-UP RENTAL | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 |
| MANAGER | 40,000 | 40,000 | 40,000 | 40,000 | 40,000 | 40,000 | 40,000 | 40,000 |
| FOREMAN | 30,000 | 30,000 | 30,000 | 30,000 | 30,000 | 30,000 | 30,000 | 30,000 |
| BOOKKEEPER | 15,000 | 15,000 | 15,000 | 15,000 | 15,000 | 15,000 | 15,000 | 15,000 |
| SITE MAINTENANCE | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 |
| ROYALTY @$15/HS | 825 | 825 | 825 | 825 | 825 | 825 | 825 | - |
| WORKING CAPITAL COST @ 1% OF GROSS REV. EXCEPT YR 17 | 4,800 | 4,800 | 4,800 | 4,800 | 4,800 | 4,800 | 4,800 | 2,400 |
| OTHER DIRECT COSTS OF PROD. + TRANSPORT, LABOUR, FUEL, ETC. @$15.03/tonne | 288,576 | 288,576 | 288,576 | 288,576 | 288,576 | 288,576 | 288,576 | - |
| VARIABLE & QUASI VAR. COSTS EXCEPTING CCA | 383,699 | 383,699 | 383,699 | 383,699 | 383,699 | 383,699 | 383,699 | 82,900 |
| TOTAL PRODUCTION (TONNES) | 19,200 | 19,200 | 19,200 | 19,200 | 19,200 | 19,200 | 19,200 | - |
| TOTAL REVENUE FROM SALES @ $25/TONNE | 480,000 | 480,000 | 480,000 | 480,000 | 480,000 | 480,000 | 480,000 | - |
| CCA RATES ON ASSETS BY CLASS | | | | | | | | |
| CCA RATE ON CLASS 6 ASSETS IS 10% PER YEAR | - | - | - | - | - | - | - | - |
| CCA RATE ON CLASS 17 ASSETS IS 8% PER YEAR | - | - | - | - | - | - | - | - |
| CCA RATE ON CLASS 10 ASSETS IS 30% PER YEAR | - | - | - | - | - | - | - | - |
| CCA RATE ON CLASS 8 ASSETS IS 20% PER YEAR | - | - | - | - | - | - | - | - |

Variable and Quasi - Variable Costs - Year 10 to 17

| SECTION SHOWING CASH FLOW: | YEAR 10 | YEAR 11 | YEAR 12 | YEAR 13 | YEAR 14 | YEAR 15 | YEAR 16 | YEAR 17 |
|---|---|---|---|---|---|---|---|---|
| CAPITAL COST ALLOWANCE (CCA) | 80,141 | 82,658 | 73,613 | 65,168 | 55,389 | 62,588 | 46,977 | - |
| UNDEPRECIATED CAPITAL COST AT END OF YEAR | 417,637 | 369,984 | 328,884 | 279,779 | 297,966 | 236,197 | 189,869 | 189,869 |
| SALE OF ASSETS IN 17TH. YR. & UNDEPRECIATED CAP. COST | - | - | - | - | - | - | - | 189,869 |
| TOTAL VAR.& QUASI VAR.COST | 383,699 | 383,699 | 383,699 | 383,699 | 383,699 | 383,699 | 383,699 | 82,988 |
| NET OPERATING REVENUE (GRS. REV. LESS TVC) | 96,381 | 96,381 | 96,381 | 96,381 | 96,381 | 96,381 | 96,381 | 186,969 |
| TAXABLE INCOME (NET OPR. REV. LESS CCA) | 16,168 | 13,451 | 22,688 | 31,141 | 48,992 | 33,721 | 49,324 | 186,969 |
| TAX PAYABLE @ CORP. RATE OF .....% 46% | 7,434 | 6,187 | 10,436 | 14,325 | 18,856 | 15,512 | 22,689 | 49,286 |
| NET INCOME OR PROFIT (TAXABLE INCOME LESS TAX PAYABLE) | 8,726 | 7,264 | 12,252 | 16,816 | 22,136 | 18,209 | 26,635 | 57,763 |
| NET OPERATING CASH FLOW (NET INCOME PLUS CCA) | 88,867 | 98,114 | 85,865 | 81,976 | 77,445 | 80,789 | 73,612 | 57,763 |
| TOTAL CASH FLOW (NET OPR. CASH FLOW PLUS CAPITAL OUTLAY) | 12,441 | 56,896 | 54,935 | 67,188 | 4,962 | 80,789 | 73,612 | 57,763 |

Cash Flow - Year 10 to 17

# APPENDIX I

## SOCIO-ECONOMIC DATA

**Estimated Number of Jobs Created by Direct Employment**

| Job Classification | Year | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | ... | ... | 20 |
| Management | 2 | 2 | 2 | 2 | ... | ... | 2 |
| Mechanic | 1 | 1 | 2 | 2 | ... | ... | 2 |
| Office Staff | 1 | 1 | 1 | 1 | ... | ... | 1 |
| Operators (seasonal) | 8 | 21 | 32 | 35 | ... | ... | 35 |
| Total | 12 | 25 | 37 | 40 | ... | ... | 40 |

**Estimated Income to Trucking Industry at $6.90/t**

| Year | Net Production (tonnes) | Revenue ($) |
|---|---|---|
| 1 | 25,000 | 172,500 |
| 2 | 50,000 | 345,000 |
| 3 | 75,000 | 517,500 |
| " | " | " |
| 20 | 75,000 | 517,500 |
| Total | 1,425,000 | 9,832,500 |

# APPENDIX J

# COMPARISON WITH EXISTING FINNISH PROJECTS

| FINLAND* | HIGH POINT BOG |
|---|---|
| Production | |
| - Production starts May 1; then stops for 2 weeks because of rain; then starts again the first week in June. | - Production starts on June 1; then stops for last 2 weeks of June; then starts again July 1. |
| - Production usually stops around August 20 because of poor drying conditions. | - Production usually stops before the 10th of September because of poor drying conditions. |
| - It rains 12 days in June, 13 days in July and 15 days in August on the average. | - In 1982 it rained 14 days in June, 17 days in July, 14 days in August and 20 days in September. |
| Field Preparation | |
| - This is a year-around activity | - Same |
| Bog Clearing | |
| - This involves brush cutting, tree removal and tree pulling. Only the large four-inch diameter trees are cut. | - Same without trees. |
| - Tree removal is usually assigned to woods contractors. | |
| Drainage | |
| - Preditching is done for all to lead away surface water. For this the Fins use the Kopo bog ditcher. During the winter this is done with a 4WD farm tractor at a rate of 150 to 250 m/hr. | - Same |
| - Main ditch and perimeter ditch is done with a backhoe at a rate of 1/2 km per day (max). | - Same |
| - Field ditches are done at a rate of 1 km/day (max). | - Same |

* data taken from discussions with Finnish Consultant.

COMPARATIVE ANALYSIS OF THE HIGH POINT BOG

WITH A SIMILAR OPERATION IN FINLAND

| FINLAND* | HIGH POINT BOG |
|---|---|
| Bridges | |
| - Construction costs (material) and labour) should be about $250/bridge | - Same |
| Stockpile | |
| - Maximum pressure occurs in pile during December. | - Not measured |
| - A rapid temperature increase occurs in August and September in a 9 m high stockpile. | - Increased in October |
| - Ignition usually occurs in Finland in late September or from two to six weeks of harvesting. | - No ignition |
| - When peat is taken from the stockpile the discharge must be complete to avoid fire. | - Same |
| Site Preparation | |
| - Access roads are first built to the site. This is always done on mineral soil. Roads are only built on the bog if forced to do so. | - Access road constructed across the bog. |
| Winter Roads | |
| - This road is capable of carrying 100 $m^3$ loads. | - No winter access roads required. |
| - The technique of constructing such a road is to keep snow away and to use tractors to shake the bog to give better frost penetration. | - Not tested |
| - The roads have a life expectancy from November to late April. | |

COMPARATIVE ANALYSIS OF HIGH POINT BOG

WITH A SIMILAR OPERATION IN FINLAND (Cont'd)

| FINLAND* | HIGH POINT BOG |
|---|---|
| Material Removal | |
| - To remove the surface materials from each field costs at least $1000/ha. | - Same |
| Milling | |
| - For conditions similar to those found on fields 40 to 50 including breaks and maintenance, the Fins expect to get 6 ha/hr of productivity. | - Rate of 1.75 ha/hr. |
| Harrowing | |
| - Normally a field will be done twice before harvesting; that is, once every four hours. | - Average of 3.8 harrowings before harvesting. |
| Ridging | |
| - During any summer an average of 17 to 20 harvests is expected. | - Average of 25 harvests for 1982. |
| - The upper limit is 80 $m^3$/ha for the Haku ridger, however, the newer units have higher blades. | - Average of (2.09 x 25) 52 $m^3$/ha. |
| - Normally 2 - 4 ridgings are done before ridge loading. | - Same |
| Ridge Loading | |
| - Normally this unit will load 60 to 70 wagons/hr. with each wagon carrying from 15 to 20 $m^3$/ load. | - Same |
| - The loading time is from 50 to 60 seconds. | - Same depending upon ridge size. |
| Tractors | |
| - Tractors used on the bog for pro duction belong to contractors. They are usually paid by the area worked starting with a basic rate of $5/hr plus some fixed rates. The $5 is only 10% of the actual pay per hour. | - Company equipment and company employees average wage of $7.80/hr. |

COMPARATIVE ANALYSIS OF HIGH POINT BOG

WITH A SIMILAR OPERATION IN FINLAND (Cont'd)

| FINLAND* | HIGH POINT BOG |
|---|---|
| Haku Unit | |
| - Normally two ridgers go with a Haku unit. | - One ridger |
| - Two harrows are raequired and need 60 HP tractors. | - Same |
| - One miller is used and requires 85 HP to operate . . . the ideal is 96 HP. | - One miller but only 70 to 80 HP used. |
| Storage | |
| - Preparation of storage area involves pipe costs, ditching and area costs, bridges, levelling and material transport costs. | - Same |
| Grading | |
| - Fields, like roads, are often graded. This is usually done after production has ceased. | - Same but screw level used for grading. |
| Paper Companies | |
| - In Finland the paper companies use a blend of peat, bark and oil with 45% and 10% respectively. | - Abitibi used 23%, 33% and 33.3%. |
| - Approximately 1,000,000 $m^3$ is delivered through the winter, that is approximately 12,000 truck loads. | - Winter delivery not practical under present arrangements. Product gets wet in storage and each time unloading, storage outside at Abitibi and loading into the infeed hopper. |
| - A contract is usually let to deliver the peat; this gives the lowest possible prices. | |
| Heat Value | |
| - The optimum heat value is needed because payment depends upon the energy produced. | - Same |
| Maintenance | |
| - For any cost or production calculations, the Fins assume 75% equipment availability. | - Considerably lower during the demo for reasons stated in section on machine utilization. |

COMPARATIVE ANALYSIS OF HIGH POINT BOG

WITH SIMILAR OPERATION IN FINLAND (Cont'd)

| FINLAND* | HIGH POINT BOG |
|---|---|
| Maintenance (Cont'd)<br><br>- Tractors are usually replaced after 3000 hours of use. | |
| Development Costs<br><br>- A conservative estimate of $10,000/ha is used by the Fins. | - Higher for the demo project. A larger scale operation and trained employees would get cost down to 10,000/ha. |
| Royalties<br><br>- Royalties are not made to the Finnish Government since profit is taxable. | - Royalties are paid. |

COMPARATIVE ANALYSIS OF HIGH POINT BOG

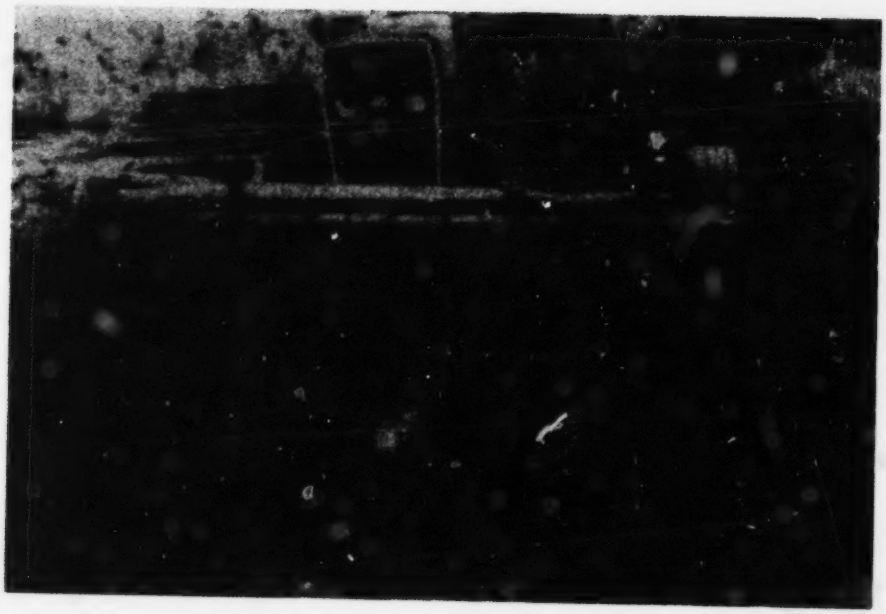
WITH SIMILAR OPERATION IN FINLAND (Cont'd)

# APPENDIX K

# PHOTOGRAPHS

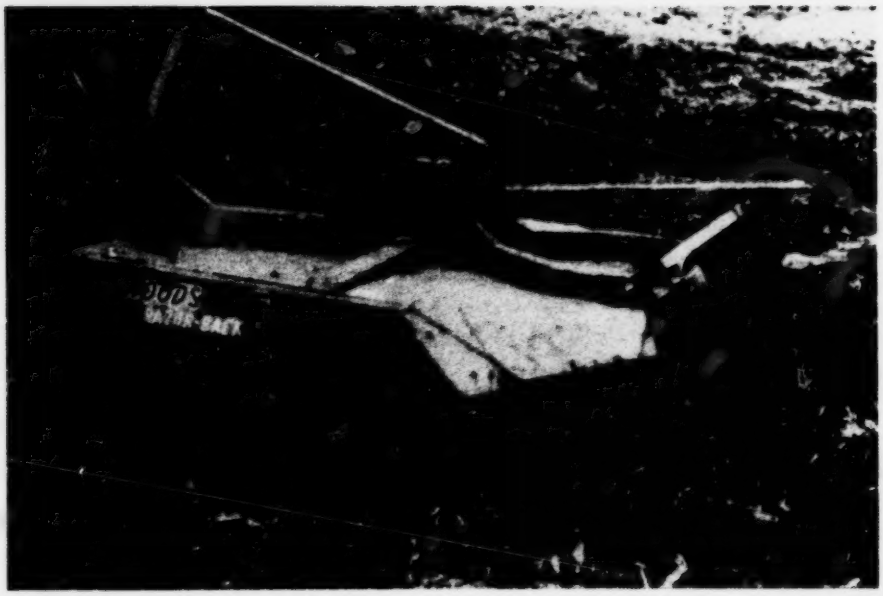
Aerial view of High Point Bog, showing the fields and ditches.

Floating road construction showing use of corduroy and reinforcing fabric



The modified (wide tracked) Massey-Ferguson tractor

The V-ditcher in use for winter ditching



Brush cutting

Rotovating

Screw-levelling (the same attachment was used for profiling)

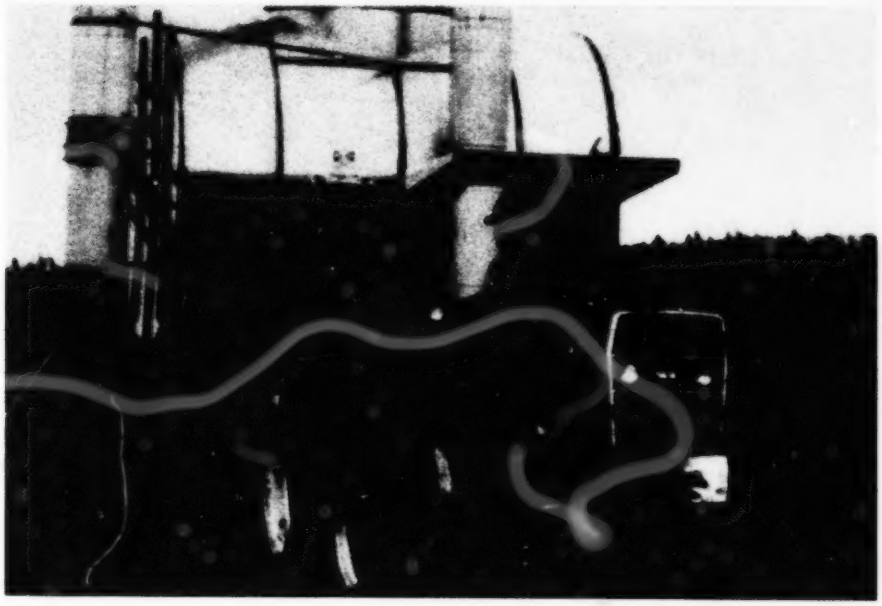
Milling

Harrowing

The ridging plough

The Haku ridge loader, showing the ridged material being picked up

The Haku ridge loader, showing the conveyor and wagon



The vacuum harvester

The vacuum harvester load being dumped at the storage area